



HAL
open science

Firm-Level Climate Change Risk and CEO Equity Incentives

Ashrafee Hossain, Abdullah-al Masum, Samir Saadi, Ramzi Benkraiem,
Nirmol Das

► **To cite this version:**

Ashrafee Hossain, Abdullah-al Masum, Samir Saadi, Ramzi Benkraiem, Nirmol Das. Firm-Level Climate Change Risk and CEO Equity Incentives. *British Journal of Management*, 2023, 34 (3), pp.1387-1419. 10.1111/1467-8551.12652 . hal-04434397

HAL Id: hal-04434397

<https://hal.science/hal-04434397v1>

Submitted on 6 Feb 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Firm-level climate change risk and CEO equity incentives

Running head (short title): Climate change risk and CEO pay

Ashrafee **Hossain**
Memorial University of Newfoundland
St. John's, NL, Canada
Email: athossain@mun.ca

Abdullah-Al Masum
University of Wisconsin-Oshkosh
800 Algoma Blvd, Oshkosh, WI 54901
Email: masuma@uwosh.edu

Samir Saadi**
University of Ottawa
Ottawa, Ontario, Canada
Email: Samir.Saadi@telfer.uOttawa.ca

Ramzi **Benkraiem**
Audencia Business School
Nantes, France
Email: rbenkraiem@audencia.com

Nirmol **Das**
The University of Memphis
Memphis, TN, USA
Email: ndas@memphis.edu

** CORRESPONDING AUTHOR. We thank Doouglas Cumming (Editor-in-Chief), Marc Goergen (Associate Editor) and three anonymous reviewers for providing valuable suggestions that helped improve our manuscript significantly. We thank Gurmeet Bhabra, Harjeet Bhabra, Lamia Chourou, Imed Chkir, Sean Cleary, Sara Ding, Darlene Himick, Mostafa Hasan, Majidul Islam, Kose John, Jon Keller, Scott Linn, Xiaobing Ma, Jinghua Nie, Mingyue Zhang, and Ligang Zhong for their valuable comments on earlier version of the paper. We also thank seminar participants at Dalhousie University of Halifax, NS (Canada) and Memorial University of Newfoundland of St. John's, NL (Canada) for their suggestive comments. A. Hossain thanks Memorial University of Newfoundland (Account # 214760 & 214315) and the Social Sciences and Humanities Research Council of Canada (SSHRC, Grant #430-2020-00275) for providing financial support. We thank William Schipper for his excellent copy editing work.

Authors declare no conflict of interest.

Firm-level climate change risk and CEO equity incentives

ABSTRACT

We document evidence that the CEOs who lead the firms that face higher climate change risk (CCR) receive higher equity-based compensation. Our finding is consistent with the *compensating-wedge-differential theory* and survives numerous robustness and endogeneity tests. The result is more prominent for firms that are socially responsible, susceptible to higher environmental litigation, and part of the non-high-tech industries. Furthermore, we find supportive evidence that the firms offering higher equity incentives to their CEOs for managing higher CCR are usually better off in the long run via a lower cost of equity capital and higher firm valuation.

JEL Codes: D81; G30; J33; Q54

Keywords: *Climate change risk; CEO equity incentive; risk mitigation; firm value*

Firm-level climate change risk and CEO equity incentives

1. Introduction

Ample anecdotal evidence reveals that climate change risk (CCR *hereafter*) severely affects economic activities and threatens future growth. The *Economist Intelligence Unit* finds that about \$4.2 trillion worth of manageable asset operates under CCR.¹ According to the fourth United States National Climate Assessment report, there is a definite possibility of a substantial decline (by about 10%) in US GDP by the end of this century due to climate-related losses.² A voluminous emerging literature on climate risk related to corporate issues also finds that CCR puts firms into unfavorable situations with a lower firm valuation (Matsumura et al., 2014), a negative stock market reaction (Bolton and Kacperczyk, 2021; Huynh and Xia, 2021), and a higher cost of external capital (Chava, 2014; Javadi and Masum, 2021). Likewise, many other studies identify CCR as a significant risk factor with serious and long-term corporate policy implications (e.g., Addoum et al., 2020; Bansal et al., 2016; Painter, 2020; etc.). Moreover, following the enhanced environmental activism and recent global awareness about climate change, it has become one of the top shareholder proposal issues. Echoing the position taken by investors, many corporations worldwide are now drafting plans to combat climate risk and have started voluntarily releasing social and environmental responsibility reports.³ One of the world's largest asset managers, BlackRock CEO Larry Fink, recently announced that they are making CCR issues central to their investment decisions. Moreover, no company will benefit from its investment unless they have solid plans to mitigate CCR.⁴ From the policy perspective, numerous laws and regulations have been drafted worldwide to encounter climate-related issues. The United States, as the world's economic leader, and especially following the recent shift in presidential administrations, has started taking serious steps against CCR.⁵ Overall, the physical, transitional, and

¹ See https://impact.economist.com/perspectives/sites/default/files/The%20cost%20of%20inaction_0.pdf

² See <https://nca2018.globalchange.gov/>

³ According to a 2017 survey by KPMG, worldwide, more than 60% of firms from all industries now release such voluntary reports.

⁴ See <https://www.blackrock.com/corporate/investor-relations/larry-fink-ceo-letter>

⁵ See, e.g., the most recent congressional report (released on October 28, 2021): <https://crsreports.congress.gov/product/pdf/R/R46947>

regulatory dimensions of CCR are undeniable. Hence, corporate risk mitigation against CCR is a pressing need.

In this study, we attempt to fill a critical research gap regarding CEO equity incentive pay (Pay *hereafter*) in response to firm-level CCR. Several pieces of split anecdotal evidence on recent policy discussions concerning CCR and CEO compensation also confirm the importance.⁶ The supposedly progressive increase in the level and pay-gap of CEO compensation compared to the average worker (particularly in the US) has been rigorously discussed for decades by academics, practitioners, policymakers, and the media (Core et al., 2008). CEO compensation might come in different forms (e.g., cash pay, bonus pay, equity pay, other pay, etc.). Lately, equity-based payment has become highly influential over other traditional forms due to its superior utility in alleviating agency concerns and incorporating risk management (Murphy, 2013). Specifically, the overall CEO compensation is often criticized for being excessive (Hill et al., 2016; Murphy, 1999). It creates perverse incentives, as the revelations of compensation scandals (Lie, 2005), and the alleged role of executive pay in the recent financial crisis (Beecher-Monas, 2011) has escalated agency issues between owners and managers. But equity-based compensation is central to CEO performances rather than their services. Thus, they have owner-like incentives (and responsibility) when firms under their leadership are better (or worse) off, thus substantially minimizing the agency issues. Besides, when it comes to corporate risk management (e.g., firm-level climate risk management in our context), it is usual for the CEOs to demand a premium for their additional responsibility and efforts required to achieve CCR goals. The augmented version of the *compensating-wage-differential-theory* of labor economics, which Adam Smith originally proposed (Smith, 1776), suggests that CEOs exposed to an increased level of risk management need enhanced efforts to mitigate the risk and should be paid a premium for the undesirable risk management. However, an increase in overall compensation often does not guarantee effective CEO performance for minimizing CCR risk. Indeed, it is most likely that with an increase in equity-based incentives, CEOs feel bound to their added responsibility, and shareholders feel relieved, knowing that it is a *win-win* scenario for both parties. The equity-based compensation creates a silver lining for

⁶ For instance, a recent article published in the Guardian [on April 15th, 2021] reveals that big oil companies pay more to their CEOs to resist climate action. Another contemporary report published in NPR [on April 20th, 2021] finds that many CEOs are likely to face a pay cut due to extended shareholder activism. See the articles: “Oil firm bosses’ pay incentivizes them to undermine climate action” <https://www.theguardian.com/environment/2021/apr/15/oil-firm-ceos-pay-is-an-incentive-to-resist-climate-action-study-finds>; “Some CEOs are hearing a new message: Act on Climate, or we’ll cut your pay” <https://www.npr.org/2021/04/20/988686847/some-ceos-are-hearing-a-new-message-act-on-climate-or-well-cut-your-pay>

CEOs and shareholders. It requires CEOs to work harder to improve productivity (i.e., firm performance) for higher personal gains. Intuitively, if a firm predicts that its financial performance will go down as a result of CCR, their pay to a CEO from equity-based compensation will also decrease. As CEOs demand a premium for risk management, firms will prefer to pay it [predominantly] through equity-based salary because it is the safer bet. Overall, we conjecture that firms facing higher CCR would be willing to offer at least a higher equity-based incentive package (if not overall) to their CEOs for risk management and corporate well-being.

We empirically test this conjecture in this study. Our measure of firm-level CCR comes from Sautner et al. (2022). Measuring CCR for corporations has proven challenging. Previous studies mostly use macro- (i.e., location or industry) level metrics that usually cannot capture the various dimensions of CCR at a time and for specific firms. Sautner et al. (2022) measure is constructed following a machine learning approach that tracks the detailed firm-level realized concerns regarding several dimensions of CCR such as physical, transitional, and regulatory risks by inspecting the transcript of each of the firm’s conference calls.⁷ Consistent with our prediction, and with the view of *compensating-wedge-differential theory*, we find that firms facing a higher level of CCR pay higher equity incentives to their CEOs. Specifically, our finding indicates that a one standard deviation increase in firm-level CCR leads to a 6.7% increase in CEO equity incentives (equivalent to a 1.15% increase over the sample mean). We document similar evidence using the percentage of CEO equity incentives of total compensation (*Pay ratio*) that largely alleviates the concern related to firm size driving the results (i.e., bigger firms usually pay more). Since all our dependent and independent variables are firm-specific with yearly-frequent variations, our main model specification includes firm and year indicator variables. Following extant CEO compensation literature, we control for common influential factors affecting CEO pay (see e.g., Hoi et al., 2019). To ensure robustness of our baseline findings, we consider several factors. *First*, to ensure that our findings are consistent irrespective of the model specifications, we rerun our analysis using industry and year fixed effects as well as high-dimensional fixed effects (i.e., industry-year and firm fixed effects) and find consistent results. *Second*, we verify that our results are insensitive to the exclusion of sample from financial and quasi-public firms, observations where CCR measure carries the value zero, and immune to the global financial crisis.

⁷ The construction of the Sautner et al. (2022) firm-level climate risk measure closely follows Hassan et al.’s (2019) methodology that measures firm-level political risk. We discuss below some of the pros and cons of this measure (see Section 3.3).

Third, we show evidence that peer firm CCR has similar impacts on the CEO equity incentive design. *Fourth*, we document that our findings are insensitive to alternate definitions of our key dependent and independent variables. *Fifth*, we attempt to rule out other possible explanations of our results by additionally considering for numerous distant factors affecting CEO pay, such as various financial constraint factors, state-level factors, social capital, and board independence, separately and collectively, but our findings continue to survive for both *Pay* and *Pay ratio*.

Still, endogeneity and identification concerns are part and parcel of any corporate empirical exploration such as ours. We attempt to address such concerns in several ways. *First*, we choose two critical events related to climate change issues and awareness to observe (namely, the release of the *Stern Review* report in 2006 and the signing of the *Paris Accord* in 2016) that should foster corporate climate risk mitigation awareness and effective strategic policies. The *Stern Review* (a 700-page report) released to the UK government in 2006 is considered one of the first and foremost detailed and comprehensive discussions about the impact of CCR on economics and business that has helped increase policy-oriented awareness regarding the issue (Stern, 2008; Painter, 2020; Javadi et al., 2022). Similarly, the signing of the *Paris Accord* in 2016 by a supermajority of countries is a milestone event. Using quasi-natural experiments, we document a surge in CEO equity incentive pay following each of the two important events – suggesting that our baseline finding is unlikely to be driven by other factors. *Second*, we perform several econometrically established conventional endogeneity checks, such as looking for sample selection or omitted variable bias. Specifically, we rerun our baseline model using propensity-score-matched (PSM) and entropy-balanced samples that confirm our earlier finding. Moreover, we conducted an Oster (2019) test to observe whether any missing factor beyond our model could influence our conclusion, but the outcome assures us that this is almost certainly unlikely.

Next, we delve deeper into this crucial issue through a cross-sectional analysis from three different perspectives. *First*, the extant literature suggests that social and environmental issues are interconnected. It is evident that more socially responsible firms feel the urgency of climate risk mitigation and act faster than socially irresponsible ones. Specifically, corporate social responsibility helps improve CEO risk-taking incentives (Dunbar et al., 2020) and mitigate CCR (Hossain and Masum, 2022). We predict therefore that more socially responsible firms would quickly and effectively adopt a higher CEO equity incentive package, given their exposure to CCR. Our cross-sectional findings also support this notion as we find that the CEO equity incentive given CCR is significantly stronger for the socially responsible firms than their counterparts. *Second*, we consider an essential

factor that numerous negative impacts of climate risk could also lead the corporations to a reputational crisis that escalates higher environmental litigation risk (Atanasova and Schwartz, 2020; Bolton and Kacperczyk, 2020; Chang et al., 2021; Delis et al., 2020; Fard et al., 2020; Javadi et al., 2022). We consistently find that firms operating in industries with higher susceptibility towards environmental litigation adopt higher level CEO equity incentive. *Third*, the extant literature documents that climate change exacerbates the creation of stranded assets via regulatory and transition risks due to CCR, which is an added challenge to corporate illiquidity of productive capital (e.g., Atansova and Schwartz, 2020; Bolton and Kacperczyk, 2020; Delis et al., 2020; Javadi et al., 2022). However, this is less of an issue for firms in high-tech industries as they have fewer tangible assets to be affected. Accordingly, we show that non-high-tech firms feel a greater need to mitigate CCR and readily provide their CEOs with a better equity incentive package when faced with higher CCR.

Furthermore, we demonstrate some financial consequences for firms that pay their CEOs a higher equity incentive for added CCR management. Specifically, we investigate whether those firms are better off in the long run, given their additional efforts to mitigate CCR. Our findings indicate that firms offering higher CEO equity incentives (when they realize that they are more susceptible to CCR) enjoy a cheaper cost of equity capital and higher long-term firm valuation. Such findings complement earlier studies by Chava (2014) and Matsumura et al. (2014), among others, as they each show that the implied cost of capital is likely to be higher and long-run firm valuation is expected to be lower for the firms facing higher environmental and climate change issues. Furthermore, in this way, our study establishes some much-needed rationale behind a firm's CCR mitigation plans that may include incentivizing their CEOs.

Our study also contributes to the literature and policy discussions in several ways. *First*, this study adds to the emerging financial-economic literature that focuses on climate change issues. Existing studies in this area focus primarily on quantifying the magnitude of CCR (see e.g., Daniel et al., 2017 and Engle et al., 2020), the capital market reaction to CCR (see e.g., Bolton and Kacperczyk, 2021; Hong et al., 2019), implications for the cost of external capital (see e.g., Chava, 2014; Huynh and Xia, 2021; Javadi and Masum, 2021; etc.), and pricing on the real estate market (see e.g., Baldauf et al., 2020; Bernstein et al., 2019). Although the mitigation of CCR has received broad policy awareness and discussion, corporate studies in this area are still minimal. In particular, to the best of our knowledge, ours is the first firm-level study that shows a link between CEO incentives and CCR. From the policy perspective, our finding can work as a toolkit for many corporations still skeptical

about mitigating CCR. Also, our finding creates room for further discussion of whether the equity incentive premium received by CEOs for their management of riskier firms is rational or involves under or over reactions given a sudden increase in awareness of this issue.

Second, our finding contributes to the split literature analyzing the link between firm-level risk and CEO equity incentive. Prior evidence on the relationship between equity incentives and risk is mixed, mainly due to issues related to the definition and proxy for risk in empirical research. Some studies find a negative relationship between the volatility of stock returns and idiosyncratic stock return volatility as proxies for risk and equity incentives (Aggarwal and Samwick, 1999; Garvey and Milbourn, 2003; Himmelberg et al., 1999; Jin, 2002). In contrast, other studies using the similar risk proxies find a positive relation between equity incentives and firm-level risk (Coles et al., 2006; Core and Guay, 1999; Oyer and Schaefer, 2005). Moreover, several studies find no significant relationship between risk and incentives (see e.g., Bushman et al., 1996). Our empirical setting helps avoid some of the common problems that have confounded many empirical studies to establish a specific link between firm-level risk and incentive pay.

Third, our research adds to the literature on executive compensation in general. Most studies have focused on firm-level or executive-level factors as determinants of equity incentives (see e.g., Amore and Failla, 2020; Conyon et al., 2019; Custódio et al., 2013; Haque and Ntim, 2020; Hartzell and Starks, 2003; Morse et al., 2011; etc.). An exception is Hoi et al. (2019), who connect local norms and networks with executive pay. Despite the plethora of research in the areas of emerging CCR and executive compensation separately, we still have much to learn about whether and how they interact. Our findings are thus informative at the very least, since they provide new evidence to fill this particular gap in the executive compensation literature which could be of help to researchers from various disciplines, corporate managers and monitors, and policymakers. Our findings will also be of interest to the infomediary (Deephouse and Heugens, 2009), given their continual coverage of executive compensation in order to push regulators to enforce corporate laws and regulations, to question the pay-for-performance skills of executives, to impose reputational costs on firms, or to drive strategic change (Bushman et al., 2017; Dyck and Zingales, 2002; Vergne et al., 2018).

We have organized the remainder of this study as follows: in Section 2, we discuss the background and develop our hypothesis; in Section 3, we describe our sample construction and

research design; in Sections 4 and 5 (and in a separate Supplemental Appendix), we present and discuss our main and supportive results of this study; and we draw some conclusions in Section 6.

2. Background and Hypothesis Development

2.1 CEO Equity Incentives

An alignment between ownership and control is an absolute necessity in modern corporations, and the conflict of interest arises between managers and shareholders with the separation of ownership and control (Jensen and Meckling, 1976). A proper design of executive compensation contracts helps mitigate such agency issues (Jensen, 1993). It is evident that until the 1990s, corporate managers were mainly compensated for their services rather than for their performance (Jensen and Murphy, 1990). This inefficient executive compensation practice has created an *empire-building incentive*, as several studies argue, and it is a source of the value destruction of corporate America. Jensen and Murphy (1990) recommend that equity-based compensation is more meaningful and effective in reducing agency concerns between managers and owners. There was a significant surge in stock-based and option-based compensation practices in the later 1990s, most likely because many companies were taking the recommendations seriously (Hall and Murphy, 2003). Under the mechanism of equity-based compensation, managerial wealth becomes tied to a firm's stock performance. Arguably, a firm's stock price is an unbiased indicator of a firm's fundamental value (Kim et al., 2011) and becomes particularly effective when a firm faces external risk (Cheng et al., 2015). Prior studies explore the impact of managerial equity incentives on firm value and document mixed outcomes. For example, Morck et al. (1988) and McConnell and Servaes (1990) argue that the relationship between managerial equity incentives and firm value is non-monotonic. John and John (1993) suggest that increased managerial equity incentives help accept riskier projects with a high net present value. Mehran (1995) finds that firm performance increases positively with equity-based executive compensation.

As the top executive of a firm, a CEO is the one primarily responsible for a firm's operations. The payoffs or compensation paid for his/her efforts often determine their commitment to the firm and its subsequent performance. Additionally, a CEO's dual role on the board and his/her influence on the appointment of outside directors often determines the efficacy of the board in general. A CEO can influence the scope of board operation since they usually control the flow of information available to the boards (Basu, 1997; Jensen, 1993). Overall, a CEO is more than an executive who possesses significant direct and indirect control over firms. Moreover, a CEO may also compromise the long-

term value of a firm, since their primary interest resides in the shorter horizon (Acharya et al., 2011), an idea consistent with the notion that a CEO may not necessarily be the most reliable agent for shareholders (Jensen, 1986 and 1993). Core et al. (1999) show that CEOs earn more while the firm underperforms and when firms suffer higher from agency problems. Poor governance cannot check higher CEO compensation, and this will usually worsen corporate performance. Intuitively, shareholders can insist on linking CEO compensation with their own interests, perhaps by offering more equity incentives. Our study therefore focuses exclusively on CEOs and their equity incentive pay rather than on other executives and total compensation. Ample contemporary studies also focus solely on CEO equity incentives - making it a *new normal* in executive compensation literature (see e.g., Armstrong et al., 2010; Benischke et al., 2019; Core, 2010; Jayaraman and Milbourn, 2015; Kim et al., 2015; Prevost et al., 2013; Qu et al., 2020; etc.).

2.2 Climate Change Risk (CCR)

CCR for corporations falls largely into three categories: physical risk, transitional risk, and regulatory risk. Physical risk is directly associated with damage to assets and disruptions in operations. This type of risk originates essentially from a firm's exposure to carbon emissions or climate-related extreme events or outcomes such as prolonged drought or a rise in sea-levels (see e.g., Chava, 2014; Hong et al., 2019; Painter, 2020). Likewise, transitional risk is linked to climate-oriented innovation that causes a shift from "*Brown to Green*," resulting in industry-specific operational disruptions (see e.g., Bolton and Kacperczyk, 2021; Delis et al., 2020). Regulatory risk emanates from regulations and policies set or designed to combat climate risk and minimize climate-oriented concerns (e.g., California's special bill, SB 32, regarding the 2030 target to reduce greenhouse gas emissions to 40% lower than 1990-levels).

Although *climate change* has been widely discussed and debated in scientific circles for many years, economic literature started to pay attention to the adverse impacts of CCR only since the seminal work of Nordhaus (1977). Nordhaus, and other studies such as Kolstad (1992), Kelly and Kolstad (1999), and Nordhaus and Popp (1997) have also produced mixed opinions as to whether CCR should have been given a much higher priority than it has in fact received. However, after some significant events such as the drafting of the Kyoto Protocol in 1997, the release of the Stern Report (in 2006), and the drafting and subsequent signing of the Paris Accord in 2015 and 2016, climate change studies concerning different corporate issues have begun receiving much more attention (see e.g., Bansal et

al., 2016; Bolton and Kacperczyk, 2021; Chava, 2014; Cogan, 2008; Dessaint and Matray, 2017; Hong et al., 2019; Huynh and Xia, 2021; Javadi and Masum, 2021; Matsumura et al., 2014; Painter, 2020; etc.). This emerging body of literature explores the adverse impacts of CCR on major corporate financial issues such as firm valuation, the cost of capital, corporate governance, and market reaction, to name a few.

Most significantly, climate change now ranks at the top among *shareholder proposal issues*. Investors increasingly consider climate change to be a legitimate risk factor. Many corporations worldwide have started releasing voluntary reports on their plans and actions to tackle CCR.⁸ In recent years, this practice has grown among Fortune Global 250 companies (44% in 2011, 55% in 2013, 65% in 2015, and 78% in 2017). Moreover, *LexisNexis* highlights the negative impacts of climate change on various aspects of business risks that the susceptibility for CCR such as physical risks, compliance risks, shareholder activism considerations, litigations risks, and regulations can amplify.⁹

2.3 Hypothesis Development

As our discussion in Section 2.2 demonstrates, CCR is a legitimate risk factor that can severely affect corporate policies from several directions. Corporations need to mitigate such risks. It is no secret that CEOs are the nucleus of modern corporations, and a proper CEO incentive design can work as *first aid* in this process of mitigation of CCR. The CEO pay literature has made abundantly clear that equity-based CEO incentives are a rational choice for ownership and control alignment, notably under risky corporate environments (Cheng et al., 2015; Jensen and Murphy, 1990).

The *compensating-wage-differential*, an age-old concept first formulated by Smith (1776) in labor economics, remains a starting point in the compensation literature. According to this theory, employees of any rank, whether top management or rank-and-file, will seek higher pay to compensate for increased need risk management (see e.g., Abowd and Ashenfelter, 2007). The underlying argument is that increased risk will expose the employees to potential job loss or diminished reputational equity in the job market, hence the need for additional pay. Thus, in our context, the

⁸ A 2017 KPMG survey reveals that more than 60% of companies across all industries worldwide voluntarily release such corporate responsibility reports on a regular basis. For an example, see this report: <https://assets.kpmg.com/content/dam/kpmg/xx/pdf/2017/10/kpmg-survey-of-corporate-responsibility-reporting-2017.pdf>

⁹ Giglio et al. (2021) do an excellent review on the emerging climate finance literature.

increased CCR could result in underperformance (Matsumura et al., 2014; Reid and Toffel, 2009), which could cost the CEO his/her job in the future; it could also diminish the reputation of the firm (see e.g., Cooper et al., 2018) for which the CEO could be blamed. As a result, it should come as no surprise that CEOs are interested in seeking higher incentives.

When the shareholders and their representatives on the corporate boards understand that their projects are susceptible to multi-dimensional climate risks that require mitigation, they look forward to hiring better quality CEOs—no doubt with better incentive packages. Understandably, given the risks involved, they are likely to offer more equity incentives than other traditional forms of compensation. Custódio et al. (2013), for example, in their analysis of market-based compensation structures of CEOs, argue that a higher pay premium in CEO pay is a distinct possibility given the complexity of the tasks assigned to CEOs. Considering that the mitigation of firm-level CCR in multiple ways is no easy task, and that awareness on this issue is now becoming increasingly clear, it is entirely plausible for firms to consider hiring CEOs with a higher equity pay premium to compensate for a firm’s extended susceptibility to CCR. As a result, we propose the following hypothesis:

H1: CEO equity incentive pay increases with firm-level climate risk.

3. Data and Research Design

3.1 Sample Construct

We rely on various sources to construct our sample. Our sample consists of 14,945 firm-year observations from 1,540 unique firms over the period from 2002 to 2018 as our climate risk proxy is not available prior to 2002. We reached our final sample by screening for data availability in Compustat, CRSP, Thomson Reuters, ExecuComp, and Sautner et al. (2022) (for climate risk data) in that order. We ensured that all variables for our main model are available for each firm-year observation. The screening process ultimately means that our sample is limited to S&P 1500 firms. Equity pay variables and all continuous control variables are winsorized at 1%/99% levels to censor any impact of outliers. However, our results are not sensitive to the use of non-winsorized data. Variable definitions and sample distribution by industry are provided in Table 1 and Table 2, respectively.

[Insert Tables 1 and 2 here]

3.2 Measuring CEO Incentive Pay and Pay Ratio

Recent studies have reported that CEOs exert significant influences in setting their own pay, and thus end up with pay levels that are unfair in some instances and often unduly high (see e.g., Bebchuk et al., 2002; Bebchuk and Fried, 2003; Bebchuk et al., 2010; Morse et al., 2011). Moreover, these studies show that equity-based pay practices are more susceptible to managerial influence (see, e.g., Yermack, 1997; Bebchuk et al., 2002; Hoi et al., 2019). Traditionally, equity-based compensation consisting of stock and option awards represents the major share of CEO pay (see e.g., Hoi et al., 2019).¹⁰ In our sample, equity-based compensation accounts for 74% of total pay, compared to about 60% reported by Hoi et al. (2019).¹¹ We focus on the equity pay of CEO compensation instead. In line with recent literature, the variable *Incentive pay* represents the natural logarithm (\ln) of one plus CEO equity-based compensation as reported in ExecuComp for a given year (see Hoi et al., 2019). Moreover, to avoid any concern over that notion that *bigger firms pay bigger incentives*, we have used another measure, *Pay ratio*, the ratio of *Incentive pay* to *Total pay* (see e.g., Custódio et al., 2013).

3.3 Measuring Climate Change Risk

Our main variable interest is firm-level CCR (*Climate risk*) provided by Sautner et al. (2022)¹². They create this measure from the bigram analysis of a firm's quarterly earnings conference calls. The measure captures a firm's risk perception resulting from physical, regulatory, and transitional climate change shocks. In the past two decades, earnings conference calls have become a primary means for firms to convey messages to their stakeholders, investors, and analysts. The managers most often utilize this opportunity to highlight their financial success during good times, and to allay fears during bad times. Sautner et al.'s CCR measure aligns with reasonable priories and exhibits both cross-sectional and time-series variations. It also correlates well with several relevant economic factors that earlier studies have developed (e.g., public attention to climate change). Notably, Sautner et al.'s methodology is similar to Hassan et al.'s (2019) widely recognized construction of firm-level political risk measure. More specifically, following Hassan et al. (2019), Sautner et al. capture CCR from the

¹⁰ This is probably due to the 1 million-dollar limit in the Tax Code §162(m) which was enacted in 1993 to limit the amount of deductible compensation that a company can pay to their CEO, CFO, and the other three most highly paid executives, with a notable exception for performance-based pay (including stock options).

¹¹ This difference is understandable as CEO-equity-incentives are increasing steadily over the past few decades, both in terms of raw dollar value and as a ratio of total pay.

¹² Available for download at <https://osf.io/fd6jq/>

conference call transcripts through a bigram analysis utilizing the frequency of key words such as “risks”, “uncertainties”, and their synonyms surrounding sentences that discuss climate change issues.

Arguably, as Sautner et al. (2022) claim, this is a better measure than using carbon emission, natural disaster, or the pollution data that many contemporary studies utilize to explore climate change related studies. For instance, the carbon emission data is generally available for companies that voluntarily disclose them, leaving out many companies who are polluters but choose not to report this data. The *Climate risk* measure provided by Sautner et al. includes a much broader range of firms. Moreover, firms do not have to be polluters themselves to face climate risk. The natural disaster-based climate datasets are macro-level data that cannot truly capture the specific climate risks all firms face.

Furthermore, Sautner et al.’s CCR measure is a multi-dimensional firm-level measure (i.e., it captures firm-specific climate risk originating with different possible origins such as physical, regulatory, and transitional aspects of CCR). Sautner et al. report that their measure is positively correlated with carbon emission and other influential climate risk measures such as Engle et al.’s (2020) index for public climate change attention.

This measure has already been recognized as useful, and has been adopted in numerous recently published studies (see e.g., Ben-Amar et al., 2022; Cook and Luo, 2021; Hossain and Masum, 2022; Wu et al., 2022; etc.). One noticeable limitation of this measure, however, is that a significant portion of the firms in our sample ignores climate change issues in every conference call (resulting in zero climate risk for those particular firm-year observations). However, we have tested our findings excluding those observations (see SA.2).

3.4 Main Regression Model

To examine the association between climate risk and CEO equity pay, we estimate the following ordinary least squares (OLS) regression model (i and t denote firm and year, respectively):

$$(Incentive\ pay\ or\ Pay\ ratio)_{i,t+1} = \alpha + \beta Climate\ risk_{i,t} + \gamma Controls_{i,t} + \phi FIRM\ FE + \lambda YEAR\ FE + \varepsilon_{i,t} \quad (Eq. 1)$$

Here, the dependent variable is *Incentive pay* or *Pay ratio* (see Section 3.2); the main independent variable is *Climate risk* (see Section 3.3).¹³ We have an array of control variables adapted from the extant CEO pay literature (see e.g., Custódio et al., 2013; Hartzell and Starks, 2003; Hoi et al., 2019). We control for the effects of size (*Firm size*), risk (*Return volatility*), leverage (*Leverage*), growth opportunities (*M/B*), as well as the tenure (*CEO tenure*) and age (*CEO age*) of the CEO. We also control for the level (*IO total*) and concentration (*IO concentration*) of institutional ownership, since they frequently influence CEO pay (see e.g., Cadman et al., 2010; Dikolli et al., 2009). We include both accounting-based (*ROA*) and stock-based (*Return*) performance measures to control for the effects of managerial ability and luck on CEO pay (see Hoi et al., 2019). We also include liquidity (*Cash*) and capital expenditures (*Capex*) as additional controls (see, Hoi et al. 2019). Notably, our baseline model considers all firm- and CEO-level control variables included in Hoi et al. (2019). In addition our key dependent variables (i.e., CEO equity incentives and CEO's equity to total pay ratio) and key independent variable (i.e., climate change risk) are firm-level variables with yearly variations. Therefore, econometrically it is rational for us to implement firm- and year-fixed effects and cluster the standard errors at the firm level.

As indicated in Section 2.3, we anticipate a positive sign for the coefficient for *Climate risk*. It is understandable that older CEOs with long tenure are more likely closer to retirement and would prefer less equity incentives and more cash pay. We expect negative coefficients for *CEO age* and *CEO tenure*. Institutional ownership (IO) can act as a gauge for external monitoring, encouraging higher levels of equity incentives more in line with agency mitigation. On the other hand, concentrated IO may cause an agency issue of its own as influential IOs may make the CEOs take initiatives that will benefit the institutions instead of the overall shareholder pool. These arguments regarding IO and IO concentration is consistent with that of the literature (see e.g., Hoi et al., 2019). Therefore, we expect a negative coefficient for *IO concentration* but a positive one for *IO total*. It is natural for larger firm CEOs to be paid at a higher level. Firms that are performing well tend to compensate their CEOs well, sometimes at rates exceeding the returns they are generating. Thus, we can expect positive coefficients for *Return* and *ROA*. Very volatile returns can create a positive or negative influence on CEO equity incentives. For example, the return could be volatile but higher than the benchmark (or target return) which would translate into higher incentive pay for the CEO. Thus, we do not formulate

¹³ For ease of interpreting regression coefficients, we multiply the original climate risk measure by 1,000.

any specific expectations here. Firms that are growing, own a sufficient amount of cash, and spend on capital projects are the ones that pay their CEOs more, because these together tend to create positive stock price movements, and CEO incentive pay is generally closely related to upward stock price movements. Hence, we can expect positive coefficients for *M/B*, *Cash* and *CAPEX*. Firms with high leverage often are in financial stress, and we can thus usually expect a negative coefficient for *Leverage*.

4. Results and Discussion

4.1 Descriptive Statistics and Correlations

Table 3 presents some descriptive statistics for the variables used in our main model. The mean value for our climate risk measure is 0.03.¹⁴ The average CEO earns \$3.7 million (\$5.08 million) in equity-based (total) compensation. These numbers are comparable to those reported in Hoi et al. (2019). We should note that our ratio of CEO equity pay to total pay (i.e., *Pay ratio*) is slightly higher than that reported in Hoi et al. The average firm is relatively healthy with an ROA of 15% and has a low leverage ratio (20%). The average size of our sample firms is \$1.8 billion ($\exp(7.51)$). The average market-to-book “MB” ratio of 3.32 suggests that the average firm has potential for future growth.

[Insert Tables 3 and 4 here]

Table 4 presents Pearson correlations of *Incentive pay* (and *Pay ratio*) with *Climate risk* and other control variables. The correlation coefficient between *Incentive pay* (*Pay ratio*) and *Climate risk* is positive and significant ($\rho=0.041$ and $\rho=0.055$, respectively; in both cases $p<0.01$). This indicates that firms facing a higher level of climate risk pay their CEOs more in equity incentives. This provides early support for our prediction formulated in hypothesis *H1*. With regard to multicollinearity issues, we observe no high Pearson correlation coefficients of concern between the main variables. This is subsequently supported by an examination of the VIFs (not tabulated).

4.2 Main Regression Results

We present our main results in Panel A of Table 5. Our model (i.e., Eq. 1) employs firm- and year fixed effects and firm-level clustered standard errors. The dependent variables are *Incentive pay* and *Pay ratio*. The coefficients for *Climate risk* in both columns 1 and 2 are positive and significant at the

¹⁴ This means that an average firm in our sample discusses exclusively about the “*risk*” or “*uncertainty*” (or synonymous) issues nearly 3% of the time when discussing climate change related issues during their corporate conference calls.

1% level (in Column [1], coef. = 0.3943 and $p < 0.01$; in Column [2], coef. = 0.0515 and $p < 0.01$). This outcome corresponds with our hypothesis *H1* (i.e., that firms pay higher CEO equity incentives when faced with higher CCR).

[Insert Table 5 here]

The magnitude of the coefficients is nontrivial, and carries economic significance. Based on the coefficient reported above in Column 1, a one-standard-deviation increase in *Climate risk* would increase *Incentive pay* by 0.067 ($0.067 = 0.17 \times 0.3943$). Since the average CEO earns \$3.47 million in equity pay, these results imply that a one-standard-deviation increase in *Climate risk*, on average, increases *Incentive pay* by 7.2%.¹⁵ By way of comparison, Hoi et al. (2019) find that a one-standard-deviation increase in Social Capital is associated with a reduction in equity pay by about 11.5%. Our impact may seem to be smaller than theirs at first glance. However, we should note that we use firm-fixed effects for our main specification. If we compare our model with industry-fixed effects like those Hoi et al. (2019) report, our impact seems higher (9.3%) than the 7.2% mentioned above.

Also, the signs on all our control variables are consistent with prior studies (e.g., a negative sign on the CEO age coefficient, a positive sign on the firm size coefficient, etc.). Specifically, as we primarily rely on Hoi et al. (2019) for the control variables, all but the sign on the ROA coefficient are consistent with their study. In contrast to Hoi et al., we find a positive but insignificant ROA coefficient. We acknowledge that this is due to our use of the firm fixed effect in the model. When we use industry- and year fixed effects, the coefficient on ROA becomes negative. Extant literature using the firm fixed effect model (e.g., Custódio et al., 2013) documents a positive but insignificant ROA coefficient like ours.

4.3 Robustness

4.3.1 Use of alternate model specifications

It is often challenging to develop a proper model specification in empirical studies like ours because it could lead to a conclusion exactly the opposite of the trend we intended to illustrate. To assure our readers that our findings are immune to such concerns (i.e., irrespective of the model

¹⁵ To illustrate the calculation, an increase of *Climate risk* by 0.17 (i.e. one S.D.) increases the level of CEO equity-based pay to \$4.04 million (where \$4.04 million = $[\exp^{(\ln(1+3774)+0.067)}-1] \times 1000$) relative to the mean level of \$3.77 million, which represents an increase of approximately 7.2%.

specifications, we get the same results), we rerun our baseline using two different sets of fixed effects that are common in the existing literature. *First*, we choose a combination of year- and industry-fixed effects. Using both of our dependent variables (i.e., *Incentive pay* and *Pay ratio*) produces a similar outcome as our baseline. *Second*, we utilize a combination of year-industry- and firm-fixed effects (also known as High Dimension or HD fixed effects) following extant empirical literature, and our findings remain consistent. We report this set of analyses in Panel B of Table 5.

4.3.2 Use of alternate sample

Another common challenge in empirical studies is choosing the appropriate sample. We attempt to address this challenge by using three alternate sets of samples.

First, the published literature often excludes observations from highly regulated industries, such as, financial, quasi-public, and utility firms. However, climate change issues are universal, and arguably such risk is vital for all firms irrespective of industry category. Specifically, the utility firms are usually not excluded in financial-economic studies discussing climate change issues since many utility firms are often considered heavy greenhouse gas emitters (see e.g., Balachandran and Nguyen, 2018; Hong et al., 2019; Javadi and Masum, 2021; Nguyen and Phan, 2020; etc.). Nevertheless, including financial and quasi-public firms in the sample could be a concern for our readers, because those are usually excluded. We have therefore rerun our baseline model excluding such firms (4-digit SIC codes: 6000 to 6999 and 9000 to 9999), following the example of the published literature (see e.g., Diamond and Rajan, 2000; Fard et al., 2020; Flannery 1994; Javadi and Masum, 2021); we can confirm the results remain consistent with our main findings. These results are reported in the supplemental appendix (see SA.1).

Second, Sautner et al. (2022) report zero CCR for a substantial number of firms in our sample. To prevent readers from concluding that our outcome is the result of including those firms in the analysis, we have rerun our baseline using only those firms that have non-zero CCR, following the example of Hossain and Masum (2022), and note that our results remain consistent. These are reported in the supplemental appendix (see SA.2).

Third, the inclusion of observation from the global financial crisis (GFC; fiscal years 2008 and 2009) is also often criticized in the extant literature because of the possibility of a biased outcome. Specifically, since our study considers facts like CEO equity incentives, risk-taking, and managing risk,

GFC is most likely to play a vital role in the mechanism (see e.g., Bhagat and Bolton, 2014; Cornett et al., 2011). Therefore, we rerun our baseline model to include a GFC dummy and exclude the GFC sample period separately to alleviate such concerns. In both cases, our results survive. To save spaces in the main part of the paper, we report these three sets of analyses in the supplemental appendix (see SA.3).¹⁶

4.3.3 Use of peer firm CCR

Firms tend to practice peer benchmarking when setting their CEO pay (see e.g., Albuquerque et al., 2013; Joakim and Andersson, 2022; Murphy and Zabochnik, 2004; Sandberg and Andersson, 2020; etc.). Thus, the focal firm's CEO pay may be driven by its benchmark's CCR. Therefore, as a measure of the robustness of our results, we have rerun our baseline model using peer firm CCR as the key independent variable, with consistent results. For this analysis, we determine peer firm CCR by taking the industry (SIC 2) average CCR that excludes the focal firm. We have reported the results in the supplemental appendix (see SA.4).

4.3.4 Use of alternate definitions of main variables

In the previous sub-section we have noted that peer CCR is a matter of significant for firms when redesigning their CEO incentives. A natural follow-up question could address whether there is any added impact of firm CCR beyond their industry peers. To investigate this question further we have reconstructed our main variables so that they only reflect upper industry-average values (so-called 'excess values'). We rerun our baseline using the newly constructed variables in three ways.

First, we replace the dependent variables of our baseline by the excess CEO incentive pay variables (i.e. the difference between firm-level measure and the median measure of its industry).

Second, we replace our key independent variable by excess CCR (i.e. the difference between firm-level measures and the median measure of its industry).

Third, we replace both of our main variables (i.e., dependent variables and key independent variable) with the excess variables. In all three cases, we have kept all else the same as our primary

¹⁶ In untabulated results, we find that our results are not sensitive to the use of 2007-2009 as GFC years as used in some studies (see e.g., Cleary and Hossain, 2020).

model, and the results are consistent with our baseline findings that CEO equity incentives increase with CCR. We report this set of analyses in the supplemental appendix (see SA.5).

4.3.5 Ruling out alternate explanations

Here we discuss the immunity of our primary outcome (i.e., high CCR firms pay higher CEO equity incentives) to several possible alternate explanations in the extant literature. We report the results in Table 6. Panel A presents results with *Incentive pay* as the dependent variable and Panel B presents results with *Pay ratio* as the dependent variable.

[Insert Table 6 here]

Our results are not sensitive to the financial constraint/distress of the firm

Recent studies have shown that financial distress risk is associated with a higher level of CEO equity incentives (see e.g., Chang et al., 2016). We could therefore argue that firms facing climate risk are possibly facing financial constraints and/or moving toward financial default (distress) and hence they are paying their CEOs more. To rule out these possibilities, we control for the Kaplan and Zingales (1997) *KZ index* (see Col. 1), the *Altman Z score* (see Col. 2), and the *Textual financial constraint* provided by Hoberg and Maksimovic (2015) (see Col. 3). Our results continue to hold.

Our results are not sensitive to the altruistic nature of the state of the firm's HQ

Earlier studies show that firms headquartered in a more altruistic locations tend to be more socially responsible (see e.g., Jha and Cox, 2015) and tend to pay their CEOs less (see e.g., Hoi et al., 2019). Hossain and Masum (2022) show that socially responsible firms face lower firm-level climate risk. A reasonable reader could combine the arguments posed by Jha and Cox and Hoi et al. with the findings of Hossain and Masum and conclude that firms in high social capital areas are more socially responsible and thus face lower firm-level climate risk and these are the firms that pay their CEOs less. In other words, social capital is what is influencing the CCR-Pay relation.

To rule out this explanation, we control for *social capital (state)* and our results continue to hold (see Col. 4). Our measure for social capital is at the state level. We use social capital data made available by the Northeast Regional Center of Rural Development (NERCD) at Penn State University.¹⁷ Recent

¹⁷ <https://aeese.psu.edu/nercrd>

studies that examine the effect of social capital on financial decisions also use these data (e.g., Hoi et al., 2019). We use this county-level data to construct a state-level measure of social capital. The social capital data for each state is the weighted average of the county-level social capital. The weights are based on the population of the county. We construct such a measure for 1997, 2005, 2009, and 2014. We then follow Hoi et al. to backfill data for the missing years using estimates of *social capital (state)* in the preceding year in which data are available. For example, we can fill in missing data from 2002 to 2004 using social capital information for 1997.

Our results are not sensitive to the state-level climate risk

While we analyze firm-level climate risk and its influence on CEO's incentive pay, it could be argued that state-level climate risk plays a role as well. In fact, majority of the studies in the climate risk niche of financial economics literature rely on state-level climate risk (e.g., Huynh et al., 2020; Javadi and Masum, 2021). To rule out the possibility that state-level climate risk is the actual driver of our results, we control for *state climate risk* (Negative PDSI: higher the score, higher is the state level climate risk) and find our result continue to hold (see Col. 5).

Our results are not sensitive to the political leaning of the state

It is generally assumed that Democrats want to tax the rich, and corporations often run afoul of this desire when they pay their CEOs excessively. There is plenty of anecdotal evidence. For example, on March 17, 2021, Senator Sanders of Vermont and his colleagues introduced a bill titled "*Tax Excessive CEO Pay*" which will (if enacted) impose a corporate tax rate increase on companies whose ratio of compensation of the CEO or other highest paid employee to median worker compensation is more than 50 to 1. Hence it could be argued that CEOs in Republican leaning states may be earning more. To rule out this possibility, we control for states with Republican leaning with a proxy of how the state voted in the last presidential election. The variable *POTUS Red* is a dichotomous variable that equals one if the state voted for a Republican presidential candidate in the preceding election and zero otherwise. Our results continue to hold (see Col. 6).

Our results are not sensitive to the corruption rate of the state

Previous studies show that CEOs in corrupt environment undertake suboptimal capital structure and investment decisions (see e.g., Hossain and Kryzanowski, 2021; Smith, 2016). It could

be argued that such a corrupt environment will dampen the check-and-balance mechanism and thus enable CEOs to obtain a higher level of pay. To rule out the possibility that state-level corruption is influencing our findings, we control for *State corruption*, and our results remain unchanged (see Col. 7). Following Hossain et al. (2021a), we extract conviction numbers for each federal judicial district from the Public Integrity Section (PIN) of the US Department of Justice (DOJ); we then aggregate these numbers at the state-level and scale it by state population in 100,000 increments.

Our results are not sensitive to the level of state environment enforcement

In the U.S., the EPA is the primary federal agency tasked with environmental protection. However, much of the EPA's permission granting, monitoring, and enforcement responsibilities, including the power to levy fines, and impose sanctions and other punitive measures are delegated to the states. Nevertheless, there is significant state-level variation in terms of the strength and enforcement of environmental regulations so that the practical application of EPA regulations is hardly uniform across states. On the one hand, states such as California actively enforce environmental regulations that are much stricter than federal regulations. On the other hand, states such as Texas and Mississippi have adopted a significantly more lenient attitude towards enforcement of environmental regulations (see e.g., Gray, 1997; Ringquist, 1993). Therefore, it could be argued that CEOs in states with stricter environment will face additional risk when they are facing climate risk. Thus, those CEOs will demand higher pay in those regions. To rule out the possibility that state-level enforcement is influencing our results, we control for *State environment enforcement* and our results still hold (see Col. 8). This measure of state-level regulatory enforcement is the total number of annual state-level enforcement actions taken based on violations of the Clean Water Act (CWA), the Clean Air Act (CAA), and the Resource Conservation and Recovery Act (RCRA), scaled by the total number of facilities regulated by the EPA in the state.¹⁸

Our results are not sensitive to governance quality

The published literature documents that governance quality proxied by board independence is an influential factor in determining CEO incentives. Ultimately, the corporate board is the entity that takes the final corporate decisions. The hiring, firing, or incentivizing of the CEOs eventually

¹⁸ Enforcement actions include both informal enforcement actions such as notifications of violation, and formal actions such as fines and administrative orders to force the violator to take action to comply with the regulations.

depend on a board's discretion (see e.g., Capezio et al., 2011; Göx and Hemmer, 2020; Guthrie et al., 2012; Laux, 2008; Mishra and Nielsen, 2000; Ozerturk, 2005; Ryan Jr. and Wiggins, 2004; etc.). Accordingly, we additionally control for the impact of board independence (see Col. 9), but it does not alter our main findings.

Notably, our main findings are insensitive to adding all the alternate explaining variables that we discuss here (see Col. 10).

4.4 Endogeneity and Identification

We strongly believe that our study does not suffer from any endogeneity issues. First, we employ a large range of control variables which should boot out any concerns related to missing endogenous factors. Second, we employ firm fixed effects in our regression specification. This should alleviate any concerns related to omitted-variables. Finally, we use a lead-lag specification which should mitigate concerns related to reverse causality (see e.g., Adams et al., 2010; Hossain et al., 2020; Hossain et al., 2021a; Hossain et al., 2021b; etc.). Nonetheless, we undertake several strategies to address endogeneity concerns such as omitted variable bias, measurement error, and reverse causality.

4.4.1 Addressing concerns related to sample selection bias

Use of Propensity Score Matched (PSM) sample

The OLS model assumes a linear relationship between the covariates and the dependent variable. If these associations are not linear then our model is susceptible to be mis-specified. To address these issues, we use propensity score matching (PSM) to construct a new sample. Unlike the OLS that assumes a linear relationship between the dependent variable and the covariates, this method does not assume any functional relation (Jha and Chen, 2015; Jha and Cox, 2015). Arguably, it is a test better suited to assess a causal association (Rosenbaum and Rubin, 1983). Several studies also use PSM sample to address sample selection bias when treated sample is not similar to the control sample (e.g., Fang et al., 2014).

To implement this method, we first divide our sample into two subsamples based on the median level of our key independent variable, *Climate risk*. We consider the subsample of firms with a below-median level of CCR as our control group and with an above-median level of *Climate risk* as the treatment group. We use a logit model to calculate the propensity score (i.e., the probability of

belonging to the high *Climate risk* firms) for both the treated and the control groups. We use all the control variables from the main model as well as year indicators to calculate propensity score. For each observation from the treated sample, we then obtain an observation from the control group. We set the caliper value equal to 0.0001, and match without replacement. Our final sample for the PSM exercise consists of 2,078 treatment firm-year observations and 2,078 control firm-year observations. Following a suggestion from Shipman et al. (2017), we conduct regression analysis using the newly constructed matched and treated samples and report the results in Col. 1 and Col. 2 of Table 7. We continue to find a positive (and significant) association between CEO *Incentive pay* and firm-level *Climate risk* (same is true for *Pay ratio* and *Climate risk*). We report the results of the diagnostics tests in the supplemental appendix, showing that there are no differences between the covariates of treatment and control groups, compared with the treatment and matched control groups (see SA.6). Notably, we find that none of the covariates show statistically significant differences between treatment and control groups.

[Insert Table 7 here]

Use of Entropy Balanced (EB) sample

Although the PSM approach is popular, it has some shortcomings, such as a substantial loss of observations. To alleviate this concern, we employ a novel approach called “*entropy balancing*” to eliminate more considerable differences in observable covariates between treatment and control groups. The aim of this method is the same as PSM, but it differs slightly from the PSM approach so that the sample size does not get reduced by a lot (see Hainmueller, 2012). Moreover, this method allows researchers to achieve a higher degree of covariate balance over PSM in terms of mean, variance, and skewness by conserving valuable information in the processed data (McMullin and Schonberger, 2020). Because of its obvious superiority over PSM, this method is increasingly being utilized in emerging social science and business research (see e.g., Amiram et al., 2017; Chapman and Green, 2018; Levy, 2021; etc.)

We largely follow the empirical methodology Hainmueller (2012) has pioneered for our analysis. We aim to converge the balanced variables on all three dimensions (i.e., mean, variance, and skewness) and eventually achieve so. We present the multivariate regression results using the sample constructed by entropy balancing in Col. 3 and Col. 4 of Table 7. We find that our results continue to

be consistent with our main findings in that the positive relation between *CEO Incentive pay (or Pay ratio)* and *Climate risk* still holds. In the supplemental appendix, we report the proof of entropy balancing (i.e., before and after comparisons for all the variables used in our main model) (see SA.7). We should note that firm-year observations with above- (below-) median levels of *Climate risk* values are placed in the treatment (control) group.

4.4.2 Identification through quasi-natural experiments

Release of Stern Review (2006) as an exogenous shock

In an attempt to address endogeneity, we employ the dissemination of the 2006 Stern Report as an exogenous shock to a firm's climate risk situation to establish a causal link between *Climate risk* and *CEO Incentive pay*. The *Stern Review*, the result of a UK government-sponsored project exceeding 700 pages long report, is generally hailed as the first comprehensive and detailed economic analysis providing an in-depth analysis of the devastating impact the climate change will have on the global economy (Painter, 2020; Stern, 2008). It is not at all far-fetched to predict that investors and regulators would become more aware of climate risks that firms face in the post-Stern world (Javadi and Masum, 2021; Javadi et al., 2022; Painter, 2020). This puts more pressure on firms and their leadership to tackle such risk. As CEO pay is pegged to the risks they take (among other things), it gives us a natural platform for evaluating the impact of a firm's climate risk on CEO pay. Our conjecture is that the repercussion of firm-level *Climate risk* will be higher in the post-Stern World and therefore, firms with higher *Climate risk* will pay their CEOs more (i.e., higher *Incentive pay*).

[Insert Table 8 here]

To test this conjecture, we follow the methodology described in Painter (2020). We first create an indicator variable *Post Stern* equal to one if the observation is from 2007 and 2008, and to zero for the years 2004 and 2005. We then add together this indicator variable and the interaction term *Climate Risk* \times *Post Stern* in our main model, and re-estimate with *Incentive pay* (and *Pay ratio*) as our dependent variable. We examine the impact of the *Stern Review* for pre- and post-period surrounding the event (see Columns [1] and [2]) using two years on each side of the report release excluding the event-year (pre=2004-5; post=2007-8). We find that *Incentive pay* (and *Pay ratio*) increase in cases of an increase in *Climate risk* in the post-Stern world. These results indicate that firms that face more climate risk in the post-Stern period are paying their CEOs incrementally higher equity incentives.

While the *Stern Review* has clear merit as an exogenous shock, our *Post Stern* (i.e., years 2007 and 2008) dummy partially coincides with the global financial crisis. Therefore, this event may not seem very effective for underpinning our arguments in favor of our baseline findings. We totally agree with this concern; to address the issue we decided to consider a similar shock, the signing of *the Paris Agreement* in 2016. We want to acknowledge that the coefficients of our interests in Columns [1] and [2] (i.e., *Climate Risk x Post Stern*) are substantially bigger than rational expectations. Although the global financial crisis may have played a significant role, the enhanced momentum of global awareness of the economic impact of climate change after the release of the *Stern Report* has demonstrably influenced CEO pay design.

Paris agreement signing (2016) as an exogenous shock

While the *Stern Report* created global awareness of climate change/climate risk and its impact on the global economy, the *Paris Agreement* was the ultimate fruit of that process, but this time with some legal teeth to it. According to the United Nations Climate Change website:

The Paris Agreement is a legally binding international treaty on climate change. It was adopted by 196 Parties at COP 21 in Paris, on 12 December 2015 and entered into force on 4 November 2016.

Its goal is to limit global warming to well below 2, preferably to 1.5 degrees Celsius, compared to pre-industrial levels.

To achieve this long-term temperature goal, countries aim to reach global peaking of greenhouse gas emissions as soon as possible to achieve a climate neutral world by mid-century.

The Paris Agreement is a landmark in the multilateral climate change process because, for the first time, a binding agreement brings all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects.¹⁹

We have therefore used the signing of the *Paris Agreement* as another exogenous shock. It was signed on April 22, 2016, and went into effect on November 4, 2016. Our prediction is that this event will have an incremental positive influence on the relationship between *Climate risk* and *Incentive pay* (or *Pay*

¹⁹ <https://www.un.org/en/climatechange/paris-agreement>.

ratio) as firms facing higher level of climate risk will be under more pressure and CEOs of those firms will demand higher pay.

To test our prediction, we have followed a methodology similar to the tests related to the *Stern Report*. We first create an indicator variable *Post Paris* equal to one if the observation is from 2017 and 2018, and zero for the years 2014 and 2015. We then add together this indicator variable and the interaction term *Climate Risk* \times *Post Paris* in our main model and re-estimate with *Incentive pay* and *Pay ratio* as our dependent variables. We examine the impact of the *Paris Agreement* for the pre- and post-period using two years on each side of the event excluding the event-year (i.e., pre=2014-15; post=2017-18; see, Columns [3] and [4]). We find that *Incentive pay* and *Pay ratio* both show an increase in *Climate risk* in the post-Paris world. These results indicate that firms that face more climate risk in the post-Paris period are paying their CEOs incrementally higher equity incentives.

Notably, the magnitude of the coefficients of our interests in Columns [3] and [4] (i.e., *Climate Risk* \times *Post Paris*) is trivial compared to what we achieve from the impact of the *Stern Review*, which, to us, is not surprising. We do not anticipate the effect to be as dramatic as was the case with the release of the *Stern Review* for several reasons. *First*, as we acknowledged before, the Post Stern period coincides with the global financial crisis, but this is clearly not the case in the Post Paris period in our analysis. *Second*, the impact of the *Paris Agreement* is likely to capture a second-order momentum only. Since the release of the *Stern Review*, many corporations have adopted their required policies, as the report points out the rationale for doing so. *Third*, one of the limitations of this study is that our sample considers the US sample only. The concurrent political regime shift (i.e., Donald Trump's being elected as the 45th President of the US; POTUS) shaped the situation differently. The US withdrew from the *Paris Agreement* temporarily and did not impose adequate actions against corporations that refrained from revising policies related to climate change as required by the *Paris Agreement*, at least from a legislative perspective. Still, US corporations could not wholly ignore the necessity because of global initiatives and extended pressure from shareholders and institutional investors (see e.g., Bolton and Kacperczyk, 2021; Delis et al., 2020; Krueger et al., 2020; etc.) Overall, the somewhat positive impact of the *Paris Agreement* in favor of our baseline findings makes sense.

4.4.3 Addressing concerns related to omitted variable bias

A common concern with empirical investigations like ours is that some important variables might be missing from the model. We have therefore undertaken a formal test based on Oster (2019)

to gauge if that is the case. Oster uses the idea that the stability of coefficients combined with R-squares from regressions with and without controls can be used to construct an identifiable set. If zero is not present in the identifiable set, then the null that a potential omitted variable is driving the results can be rejected (see also Altonji et al., 2005). The identified set is defined as: $[\tilde{\beta}, \beta^{*'}]$ where $\beta^{*'}$ is derived using the following formula:

$$\beta^{*' } = \tilde{\beta} - \delta[\hat{\beta} - \tilde{\beta}] \frac{R_{max} - \tilde{R}}{\tilde{R} - \hat{R}} \quad (\text{Eq. 2})$$

Here $\tilde{\beta}$ and \tilde{R} are the estimated coefficients of our main research variable and the R-square value from the baseline model with all controls (see Columns [1] and [2] of Panel A of Table 5); and $\hat{\beta}$ and \hat{R} are their counterparts from the uncontrolled regression with no control variables and no fixed effects (not tabulated). Values for δ and R_{MAX} are chosen by the researcher. We rely on the Oster (2019) argument that the appropriate upper bound for δ is 1 which implies that the omitted variables need to be as influential as the included ones to make the value of the research coefficient equal to zero.

In constructing the upper Oster bound for the identified sets, we use the more conservative Mian and Sufi (2014) value of $R_{max} = \min(2.2\tilde{R}, 1)$ in the upper panel and the extreme one from Oster (2019) of $R_{MAX} = 1$ in the lower panel. In his study Oster notes: “*I find only about 9% to 16% of results would survive $R_{MAX} = 1$ [and $\delta = 1$]*” (Oster, p. 200). This is not surprising since R_{MAX} is the hypothetical R-square value of the regression that includes both omitted and included variables, which, by definition, cannot exceed one. We report the results from this analysis in the supplemental appendix (see SA.8). Results show that none of our identified sets include zero. Therefore, it seems reasonable to conclude that it is highly unlikely that the inferences from our OLS specifications presented in Table 5 suffer from an omitted variables bias.

4.5 Cross-sectional Tests

4.5.1 Socially responsible vs. irresponsible firms

For several reasons, corporate social responsibility (CSR) is likely to play a moderating role in our study. *First*, the extant literature on CEO equity incentives finds evidence that higher CSR initiatives foster CEO risk-taking incentives that lead to higher CEO equity pay (Armstrong and Vashishtha, 2012; Coles et al., 2006; Dunbar et al., 2020). *Second*, greenwashing (i.e., increased CSR

activities to conceal environmentally unfriendly tags) has become a widespread corporate practice (Balluchi et al., 2020; Hossain et al., 2022; Marquis et al., 2016; Pizzetti et al., 2021; Wu and Shen, 2013; Zhang, 2022). *Third*, CSR has proved to be effective in reducing CCR (Hossain and Masum, 2022). We conjecture therefore that socially responsible firms would be the champions in quickly adopting a higher CEO equity incentive following higher CCR. To test this conjecture, we divide our sample into two sub-groups: socially responsible and irresponsible firms. We follow Lins et al. (2017) methodology to set the benchmark. Specifically, if a firm's overall CSR score is positive (negative), we tag that firm as a socially responsible (irresponsible) firm. When we rerun our baseline model using these two subsample groups, we only find significant positive coefficients on *Climate risk* for the socially responsible group for both of our dependent variables (i.e., *Incentive pay* and *Pay ratio*). We report these results in Panel A of Table 9. Notably, the magnitudes of the *Climate risk* coefficients for the socially responsible group are almost double those of the socially irresponsible group. Our *Chi-square test* further ensures that these two groups are significantly different.

[Insert Table 9 here]

4.5.2 High vs. low environmental litigation firms

One of the most important reasons corporations should care deeply about CCR, apart from the regular financial consequences, is that CCR concerns can easily transform into reputational and litigation risks. Often, they result in legal actions that may lead to severe financial penalties (Fard et al., 2020; Chang et al., 2021). For instance, *British Petroleum* had to pay more than \$42 billion to resolve the environmental litigation instigated the gross negligence demonstrated in the oil spill in the Gulf of Mexico.²⁰ Intuitively, firms operating under the industry umbrella that historically faced higher environmental litigation likely feel a greater need for CCR mitigation plans than others. Therefore, our anticipation that firms facing a higher natural susceptibility for environmental litigation would readily pay their CEOs higher equity incentives when facing CCR seems entirely reasonable. To test this conjecture, we split our sample into high vs. low environmental litigation risk sub-groups. We follow Fard et al. (2020) in defining *High Environmental Lit. Risk* industry groups (2-digit SIC codes: 49, 28, 29, 37, 13, 36, 35, 33, 38, 26, and 10). However, contrary to our anticipation, our cross-sectional analysis finds that firms belonging to industries with higher environmental litigation risk drive the

²⁰ See <https://www.nbcnews.com/business/business-news/bp-found-guilty-grossly-negligent-gulf-oil-spill-n195781>

baseline results. Specifically, we find that the *Climate risk* coefficients are positive and significant only for the high environmental litigation group subsample. The *Chi-square test* also confirms that the difference between high vs. low environmental litigation risk groups is substantial. We report the results in Panel B of Table 9.

4.5.3 *High-tech vs. non-high-tech firms*

Another important reason for corporations to consider CCR seriously is that it often creates stranded assets that are most likely to make productive capital largely illiquid (Atansova and Schwartz, 2020; Delis et al., 2020; Javadi et al., 2022). This scenario is less pronounced for high-tech industry firms since they need to rely less on tangible assets than their counterparts. Thus, we predict that non-high-tech industry firms would drive our results as they need to be more cautious when faced with CCR and act faster in revising policies to combat CCR, such as paying higher equity incentives to their CEOs. Following Loughran and Ritter (2004) and Masulis et al. (2007), among others, we split our sample into *High-tech* vs. *Non-high-tech* sub-groups. Consistent with our forecast, we observe that *Non-high-tech* firms are in the driver's seat. A *Chi-square test* comparison also supports this intuition. We report the results in Panel C of Table 9.

5. Additional Analysis

5.1 *Climate Change Risk, CEO Equity Pay, and Implied Cost of Capital*

We have shown in the previous section that socially responsible firms tend to pay their CEOs more with equity incentives when faced with CCR compared to socially irresponsible firms. Chava (2014) documents that environmental concern (i.e., social irresponsibility regarding environmental issues) increases a firm's implied cost of capital (ICC *hereafter*, an ex-ante expected stock returns (see Chava and Purnanandam, 2010; Gebhardt et al., 2001; and Pástor et al., 2008 for detailed methodology and its advantages over the realized returns). This finding in the literature pose an interesting question about the role (if any) CEO equity incentives play in the relationship between CCR and ICC. We predict that one of two things may happen. On the one hand, the market may perceive higher equity-based pay for CEOs of firms with higher CCR positively since this may entice the CEOs to take initiatives to mitigate CCR (a positive view). On the other hand, the market could perceive this negatively as this may also make the CEOs indifferent to taking necessary initiatives to mitigate CCR

(a negative view). In sum, this is an empirical question that we are investigating here. We use the following regression model:

$$ICC_{i,t} = \alpha + \beta * Climate\ risk_{i,t} \times (Incentive\ pay\ or\ Pay\ ratio)_{i,t} + \omega * Climate\ risk_{i,t} + \theta * (Incentive\ pay\ or\ Pay\ ratio)_{i,t} + \gamma * Controls_{i,t} + \phi * FIRM\ FE + \lambda * YEAR\ FE + \varepsilon_{i,t} \quad (Eq. 3)$$

where the dependent variable is the *ICC* of the firm. We use two methods to calculate the *ICC*, namely, Ohlson and Juettner-Nauroth's (2005) model (*ICC_{OJN}*) and Easton's (2004) model (*ICC_{MPEG}*). Our main variable of interest is the interaction terms between the pay variables and CCR. We orthogonalize incentive pay and pay ratio with respect to CCR so that the interaction term does not capture the commonality as we show in this study.²¹ The model includes various controls used in the literature (see e.g., Chava, 2014; El Ghoul et al., 2012).²²

[Insert Table 10 here]

Our results are reported in Panel A of Table 10. We find that interaction terms are consistently negative and significant. This means that facing a higher level of climate risk, when firms pay higher equity incentives to their CEOs, the market does not perceive it negatively. This is substantiated by a lower *ICC* for the interaction terms. It should be noted that the coefficient for *Climate risk* is consistently positive, i.e., *ICC* is higher for firms that face more CCR—consistent with the literature (see e.g., Bolton and Kacperczyk, 2021; Chava, 2014). While these findings provide some evidence for the rationality of a positive CCR-Pay relationship, further discussion is beyond the scope of this study, and we will therefore leave this for future investigation.

5.2 Climate Change Risk, CEO Equity Pay, and Firm Valuation

Matsumura et al. (2014) argue that financial markets penalize corporations for being environmentally unfriendly (e.g., emitting greenhouse gases) in terms of firm valuation, but not those

²¹ Specifically, throughout the paper, we use *Incentive pay* and *Pay ratio* as the dependent variables, and we establish that they are a function of CCR. But here we use both of these variables and CCR, together as the interacted term in the right-hand side. Therefore, it could have been problematic if we do not orthogonalize. However, we can assure readers that irrespective of the orthogonalization, our findings remain the same.

²² Controls include: *Firm size* (the log of total assets); *Leverage* (the ratio of total debt to total assets); *M/B* (the market-to-book value of equity); *Return* (average monthly return for a stock for the preceding year); *Return volatility* (standard deviation of those monthly returns); *ROA* (return on assets); *Long term growth* (reported in I/B/E/S); *Dispersion* (the standard deviation of analyst forecasts); and *Stock beta* (the stock's market beta).

showing some sort of responsibility in their efforts to mitigate environmental concerns such as voluntarily disclosing their emission status. Also, we already have evidence from the previous section that in such situations CCR and concomitant CEO equity pay is likely to help reduce the implied cost of capital for the firms. Accordingly, we predict that if firms facing CCR take some initiatives such as strategically increasing CEO equity incentives in our context, financial markets would perceive it positively in terms of firm valuation. Specifically, we ask here whether CEO equity incentives play a role in the relationship between CCR and firm value. Similar to our previous analysis, we use the following regression model:

$$Tobin's\ Q_{i,t}\ (or\ Industry\ adjusted\ Q)_{i,t} = \alpha + \beta * Climate\ risk_{i,t} \times (Incentive\ pay\ or\ Pay\ ratio)_{i,t} + \omega * Climate\ risk_{i,t} + \theta * (Incentive\ pay\ or\ Pay\ ratio)_{i,t} + \gamma * Controls_{i,t} + \phi * FIRM\ FE + \lambda * YEAR\ FE + \varepsilon_{i,t} \quad (Eq.\ 4)$$

In Eq. 4, the dependent variable is *Tobin's Q* (a commonly used proxy for firm valuation in the extant literature). As robustness, we use *Industry adjusted Q* (i.e. the difference between a firm's Q and the industry median Q for year t) as another proxy of firm valuation. Our calculation of firm valuation proxies (i.e., Tobin's Q and Industry adjusted Q) follows established studies (see Eisenberg et al., 1998; Jiao, 2010; Villalonga and Amit, 1998). We are mainly interested here in the coefficients of the interaction terms between CEO equity pay variables and CCR. In our analysis in Section 5.1, CEO equity pay variables are made orthogonal before taking the interaction. The control variables are adopted from the extant literature offering a similar firm valuation analysis (see e.g., Villalonga and Amit, 1998). Consistent with our expectation, we find here that firm valuation increases with higher CEO equity incentives given CCR – another source of motivation for firms to adopt CCR mitigation policies. We report the results in Panel B of Table 10.

6. Conclusion

Our study explores whether firm-level CCR influences CEO equity incentive design and finds this the most likely conclusion to draw. Consistent with the *compensating-wage-differential theory*, our findings strongly support the view that firms pay higher CEO incentives when faced with higher firm-level climate risk. We specifically focus on the CEO equity incentives rather than on any other forms of compensation (such as *cash pay*, *bonus pay*, and *other pay*) because equity incentives are the most relevant form of compensation for firm-level risk management (Cheng et al., 2015; Jensen and Murphy, 1990; Mehran, 1995). Our findings are based on a firm-fixed effect model that also employs

a lead-lag effect, and it survives a battery of tests regarding robustness, endogeneity, and identification. Notably, we find that an increase in awareness about climate change issues in the corporate world (i.e., following the release of the *Stern Review* report in 2006 and the signing of *the Paris Accord* in 2016) has added momentum to the documented relationship. Our cross-sectional tests further reveal that the relationship becomes more potent using sub-samples of socially responsible firms, corporations more susceptible to environmental litigation, and firms from non-high-tech industries. This study contributes to the literature on multiple fronts, such as the emerging business literature related to climate change issues, the CEO equity incentive literature following firm-level risk, and the overall CEO compensation literature. Altogether, our study creates room for future research on, for example, whether extensive CEO incentive pay is rational compared to the magnitude of firm-level climate risk or is just hyperbole following sudden or extended climate risk awareness. Furthermore, it will help revise existing corporate policies, such as determining CEO incentive pay premiums following firm-level climate risk exposure.

Similarly, our primary evidence can be further extended to the international level (collectively or from a single nation perspective), considering that the scope of our study is limited to the US. The industry-specific implications can also be closely observed as we show that different industry classes (e.g., high-tech vs. non-high-tech, industries with higher vs. lower environmental litigation) have different reactions to CCR. While Sautner et al.'s (2022) measure of CCR gives us an edge over other conventional proxies because of its capability to access firm-level CCR, a possible limitation could exist in how the risk is being measured (i.e., utilizing the transcript of corporate conference calls). It is also possible that any release of such firm-level climate risks during conference calls by the corporate managers is strategic. Specifically, our cross-sectional findings of socially responsible firms driving the results can create room for debate whether firm-level CCR is a new means of “greenwashing” by managers to enhance their incentives. Moreover, the findings from our additional consequence analyses (i.e., an increase of firm value and a decrease in the cost of implied capital) deserve further dissection. One could, for example, [be](#) looking for other related channels and mechanisms for enhancing firm valuation.

The managerial and policy-level implications of our study are also crucial. For instance, as corporations see the apparent benefits of CCR mitigation plans, CEO experience in managing high-CCR firms could prove a positive factor in their resumes from the perspective of labor investment efficiency. Last but not least, our study can be extended to other top-level executives under the CEO

(i.e., subordinate executives), expanding the analysis beyond the limited scope of our study. In other words, the management of CCR could require the development of solid teamwork at the executive-level. The “CEO tournament incentive” is another closely related issue where CCR (and higher CEO equity incentives in such cases) could play a vital role. Overall, we hope our study leaves enough guidelines for many future studies in this broad subject.

References

- Abowd, J. M., & Ashenfelter, O. (2007). Anticipated unemployment, temporary layoffs, and compensating wage differentials. In S. Rosen (Ed.), *Studies in Labor Markets* (pp. 141-170). University of Chicago Press.
- Acharya, V. V., Myers, S. C., & Rajan, R. G. (2011). The internal governance of firms. *The Journal of Finance*, *66*(3), 689-720.
- Adams, J. C., Mansi, S. A., & Nishikawa, T. (2010). Internal governance mechanisms and operational performance: Evidence from index mutual funds. *The Review of Financial Studies*, *23*(3), 1261-1286.
- Addoum, J. M., Ng, D. T., & Ortiz-Bobea, A. (2020). Temperature shocks and establishment sales. *The Review of Financial Studies*, *33*(3), 1331-1366.
- Aggarwal, R. K., & Samwick, A. A. (1999). The other side of the trade-off: The impact of risk on executive compensation. *Journal of Political Economy*, *107*(1), 65-105.
- Albuquerque, A. M., De Franco, G., & Verdi, R. S. (2013). Peer choice in CEO compensation. *Journal of Financial Economics*, *108*(1), 160-181.
- Altonji, J. G., Elder, T. E., & Taber, C. R. (2005). Selection on observed and unobserved variables: Assessing the effectiveness of Catholic schools. *Journal of Political Economy*, *113*(1), 151-184.
- Amiram, D., Beaver, W. H., Landsman, W. R., & Zhao, J. (2017). The effects of credit default swap trading on information asymmetry in syndicated loans. *Journal of Financial Economics*, *126*(2), 364-382.
- Amore, M. D., & Failla, V. (2020). Pay dispersion and executive behaviour: evidence from innovation. *British Journal of Management*, *31*(3), 487-504.
- Armstrong, C. S., & Vashishtha, R. (2012). Executive stock options, differential risk-taking incentives, and firm value. *Journal of Financial Economics*, *104*(1), 70-88.
- Armstrong, C. S., Jagolinzer, A. D., & Larcker, D. F. (2010). Chief executive officer equity incentives and accounting irregularities. *Journal of Accounting Research*, *48*(2), 225-271.
- Atanasova, C., & Schwartz, E. S. (2020). *Stranded fossil fuel reserves and firm value* (No. w26497). National Bureau of Economic Research.
- Balachandran, B., & Nguyen, J. H. (2018). Does carbon risk matter in firm dividend policy? Evidence from a quasi-natural experiment in an imputation environment. *Journal of Banking & Finance*, *96*, 249-267.
- Baldauf, M., Garlappi, L., & Yannelis, C. (2020). Does climate change affect real estate prices? Only if you believe in it. *The Review of Financial Studies*, *33*(3), 1256-1295.
- Balluchi, F., Lazzini, A., & Torelli, R. (2020). CSR and Greenwashing: A Matter of Perception in the Search of Legitimacy. In M. Del Baldo, J. Dillard, M. G. Baldarelli, and M. Ciambotti (Eds.) *Accounting, Accountability and Society: Trends and Perspectives in Reporting, Management and Governance for Sustainability* (pp. 151-166). Springer, Cham.
- Bansal, R., Kiku, D., & Ochoa, M. (2016). *Price of long-run temperature shifts in capital markets* (NBRT Working Papers No. w22529). National Bureau of Economic Research.
- Basu, S. (1997). The conservatism principle and the asymmetric timeliness of earnings. *Journal of Accounting and Economics*, *24*(1), 3-37.
- Bebchuk, L. A., & Fried, J. M. (2003). Executive compensation as an agency problem. *Journal of Economic Perspectives*, *17*(3), 71-92.
- Bebchuk, L. A., Fried, J. M., & Walker, D. I. (2002). *Managerial power and rent extraction in the design of executive compensation* (NBER Working Papers No. w9068). National Bureau of Economic Research.
- Bebchuk, L. A., Grinstein, Y., & Peyer, U. (2010). Lucky CEOs and lucky directors. *The Journal of Finance*, *65*(6), 2363-2401.

- Beecher-Monas, E. (2011). The risks of reward: The role of executive compensation in financial crisis. *Virginia Law & Business Review*, 6(1), 101-144.
- Ben-Amar, W., Gomes, M., Khurshed, H., & Marsat, S. (2022). Climate change exposure and internal carbon pricing adoption. *Business Strategy and the Environment*. <https://doi.org/10.1002/bse.3051>.
- Benischke, M. H., Martin, G. P., & Glaser, L. (2019). CEO equity risk bearing and strategic risk taking: The moderating effect of CEO personality. *Strategic Management Journal*, 40(1), 153-177.
- Bernstein, A., Gustafson, M. T., & Lewis, R. (2019). Disaster on the horizon: The price effect of sea level rise. *Journal of Financial Economics*, 134(2), 253-272.
- Bhagat, S., & Bolton, B. (2014). Financial crisis and bank executive incentive compensation. *Journal of Corporate Finance*, 25, 313-341.
- Bolton, P., & Kacperczyk, M. (2021). Do investors care about carbon risk? *Journal of Financial Economics*. 142(2), 517-549.
- Bushman, R. M., Indjejikian, R. J., & Smith, A. (1996). CEO compensation: The role of individual performance evaluation. *Journal of Accounting and Economics*, 21(2), 161-193.
- Bushman, R.M., Williams, C.D., & Wittenberg-Moerman, R. (2017), The informational role of the media in private lending. *Journal of Accounting Research*, 55(1), 115-152.
- Cadman, B., Klasa, S., & Matsunaga, S. (2010). Determinants of CEO pay: A comparison of ExecuComp and non-ExecuComp firms. *The Accounting Review*, 85(5), 1511-1543.
- Capezio, A., Shields, J., & O'Donnell, M. (2011). Too good to be true: board structural independence as a moderator of CEO pay-for-firm-performance. *Journal of Management Studies*, 48(3), 487-513.
- Chang, W. J., Hayes, R. M., & Hillegeist, S. A. (2016). Financial distress risk and new CEO compensation. *Management Science*, 62(2), 479-501.
- Chang, X. S., Fu, K., Li, T., Tam, L., & Wong, G. (February 28, 2021). *Corporate environmental liabilities and capital structure*. Available at SSRN: <https://ssrn.com/abstract=3200991>.
- Chapman, K., & Green, J. R. (2018). Analysts' influence on managers' guidance. *The Accounting Review*, 93(1), 45-69.
- Chava, S. (2014). Environmental externalities and cost of capital. *Management science*, 60(9), 2223-2247.
- Chava, S., & Purnanandam, A. (2010). CEOs versus CFOs: Incentives and corporate policies. *Journal of Financial Economics*, 97(2), 263-278.
- Cheng, Y., Harford, J., & Zhang, T. T. (2015). Bonus-driven repurchases. *Journal of Financial and Quantitative Analysis*, 50(3), 447-475.
- Cleary, S., & Hossain, A. (2020). Postcrisis M&As and the impact of financial constraints. *Journal of Financial Research*, 43(2), 407-454.
- Cogan, D. G. (2008). *Corporate governance and climate change: The banking sector*. A Ceres Report. Ceres.
- Coles, J. L., Daniel, N. D., & Naveen, L. (2006). Managerial incentives and risk-taking. *Journal of Financial Economics*, 79(2), 431-468.
- Conyon, M. J., Hass, L. H., Peck, S. I., Sadler, G. V., & Zhang, Z. (2019). Do compensation consultants drive up CEO pay? Evidence from UK public firms. *British Journal of Management*, 30(1), 10-29.
- Cook, D. O., & Luo, S. (2021). Does perception of social issues affect portfolio choices? Evidence from the #MeToo movement. *Financial Management*, 51(2), 613-634.
- Cooper, S. A., Raman, K. K., & Yin, J. (2018). Halo effect or fallen angel effect? Firm value consequences of greenhouse gas emissions and reputation for corporate social responsibility. *Journal of Accounting and Public Policy*, 37(3), 226-240.
- Core, J. E. (2010). Discussion of chief executive officer equity incentives and accounting irregularities. *Journal of Accounting Research*, 48(2), 273-287.

- Core, J. E., Holthausen, R. W., & Larcker, D. F. (1999). Corporate governance, chief executive officer compensation, and firm performance. *Journal of Financial Economics*, 51(3), 371-406.
- Core, J. F., Guay, W., & Larcker, D. F. (2008). The power of the pen and executive compensation. *Journal of Financial Economics*, 88(1), 1-25.
- Core, J., & Guay, W. (1999). The use of equity grants to manage optimal equity incentive levels. *Journal of Accounting and Economics*, 28(2), 151-184.
- Cornett, M. M., McNutt, J. J., Strahan, P. E., & Tehranian, H. (2011). Liquidity risk management and credit supply in the financial crisis. *Journal of Financial Economics*, 101(2), 297-312.
- Custódio, C., Ferreira, M. A., & Matos, P. (2013). Generalists versus specialists: Lifetime work experience and chief executive officer pay. *Journal of Financial Economics*, 108(2), 471-492.
- Daniel, K. D., Litterman, R. B., & Wagner, G. (2017). *Applying asset pricing theory to calibrate the price of climate risk* (No. w22795). National Bureau of Economic Research.
- Deephouse, D., & Heugens, P. (2009). Linking social issues to organizational impact: The role of infomediaries and the infomediary process. *Journal of Business Ethics*, 86(4), 541-553.
- Delis, M. D., de Greiff, K., & Ongena, S. (2020). *Being stranded with fossil fuel reserves? Climate policy risk and the pricing of bank loans*. (EBRD Working Papers, No. 231). European Bank for Reconstruction and Development.
- Dessaint, O., & Matray, A. (2017). Do managers overreact to salient risks? Evidence from hurricane strikes. *Journal of Financial Economics*, 126(1), 97-121.
- Diamond, D. W., & Rajan, R. G. (2000). A theory of bank capital. *The Journal of Finance*, 55(6), 2431-2465.
- Dikolli, S. S., Kulp, S. L., & Sedatole, K. L. (2009). Transient institutional ownership and CEO contracting. *The Accounting Review*, 84(3), 737-770.
- Dunbar, C., Li, Z. F., & Shi, Y. (2020). CEO risk-taking incentives and corporate social responsibility. *Journal of Corporate Finance*, 64, 101714.
- Dyck, A., & Zingales, L. (2002). *The corporate governance role of the media*. (NBER Working Papers No. w9309) National Bureau of Economic Review.
- Easton, P. D. (2004). PE ratios, PEG ratios, and estimating the implied expected rate of return on equity capital. *The Accounting Review*, 79(1), 73-95.
- Eisenberg, T., Sundgren, S., & Wells, M. T. (1998). Larger board size and decreasing firm value in small firms. *Journal of Financial Economics*, 48(1), 35-54.
- El Ghouli, S., Guedhami, O., Ni, Y., Pittman, J., & Saadi, S. (2012). Does religion matter to equity pricing? *Journal of Business Ethics*, 111(4), 491-518.
- Engle, R. F., Giglio, S., Kelly, B., Lee, H., & Stroebel, J. (2020). Hedging climate change news. *The Review of Financial Studies*, 33(3), 1184-1216.
- Fang, V. W., Tian, X., & Tice, S. (2014). Does stock liquidity enhance or impede firm innovation? *The Journal of Finance*, 69(5), 2085-2125.
- Fard, A., Javadi, S., & Kim, I. (2020). Environmental regulation and the cost of bank loans: International evidence. *Journal of Financial Stability*, 51, 100797.
- Flannery, M. J. (1994). Debt maturity and the deadweight cost of leverage: Optimally financing banking firms. *The American Economic Review*, 84(1), 320-331.
- Garvey, G., & Milbourn, T. (2003). Incentive compensation when executives can hedge the market: Evidence of relative performance evaluation in the cross section. *The Journal of Finance*, 58(4), 1557-1582.
- Gebhardt, W. R., Lee, C. M., & Swaminathan, B. (2001). Toward an implied cost of capital. *Journal of Accounting Research*, 39(1), 135-176.
- Giglio, S., Kelly, B., & Stroebel, J. (2021). *Climate finance*. (NERB Working Papers No. w28226). National Bureau of Economic Review.

- Göx, R. F., & Hemmer, T. (2020). On the relation between managerial power and CEO pay. *Journal of Accounting and Economics*, 69(2-3), 101300.
- Gray, W. B. (1997). *Manufacturing plant location: Does state pollution regulation matter?* (NBER Working Paper No. 5880). National Bureau of Economic Research.
- Guthrie, K., Sokolowsky, J., & Wan, K. M. (2012). CEO compensation and board structure revisited. *The Journal of Finance*, 67(3), 1149-1168.
- Hainmueller, J. (2012). Entropy balancing for causal effects: A multivariate reweighting method to produce balanced samples in observational studies. *Political Analysis*, 20(1), 25-46.
- Hall, B. J., & Murphy, K. J. (2003). The trouble with stock options. *Journal of Economic Perspectives*, 17(3), 49-70.
- Haque, F., & Ntim, C. G. (2020). Executive compensation, sustainable compensation policy, carbon performance and market value. *British Journal of Management*, 31(3), 525-546.
- Hartzell, J. C., & Starks, L. T. (2003). Institutional investors and executive compensation. *The Journal of Finance*, 58(6), 2351-2374.
- Hassan, T. A., Hollander, S., Van Lent, L., & Tahoun, A. (2019). Firm-level political risk: Measurement and effects. *The Quarterly Journal of Economics*, 134(4), 2135-2202.
- Hill, M. S., Lopez, T. J., & Reitenga, A. L. (2016). CEO excess compensation: The impact of firm size and managerial power. *Advances in Accounting*, 33(June), 35-46.
- Himmelberg, C. P., Hubbard, R. G., & Palia, D. (1999). Understanding the determinants of managerial ownership and the link between ownership and performance. *Journal of Financial Economics*, 53(3), 353-384.
- Hoberg, G., & Maksimovic, V. (2015). Redefining financial constraints: A text-based analysis. *The Review of Financial Studies*, 28(5), 1312-1352.
- Hoi, C. K. S., Wu, Q., & Zhang, H. (2019). Does social capital mitigate agency problems? Evidence from Chief Executive Officer (CEO) compensation. *Journal of Financial Economics*, 133(2), 498-519.
- Hong, H., Li, F. W., & Xu, J. (2019). Climate risks and market efficiency. *Journal of Econometrics*, 208(1), 265-281.
- Hossain, A. T., Hossain, T., & Kryzanowski, L. (2021a). Political corruption and corporate payouts. *Journal of Banking & Finance*, 123, 106016.
- Hossain, A. T., Hossain, T., & Kryzanowski, L. (2021b). Social environment and corporate payouts. *The European Journal of Finance*, 27(14), 1413-1437.
- Hossain, A. T., & Masum, A. A. (2022). Does corporate social responsibility help mitigate firm-level climate change risk? *Finance Research Letters*, 102791. <https://doi.org/10.1016/j.frl.2022.102791>
- Hossain, A. T., & Kryzanowski, L. (2021). Political corruption and cost of equity. *Business & Society*, 60(8), 2060-2098.
- Hossain, A. T., Kryzanowski, L., & Ma, X. B. (2020). US political corruption and loan pricing. *Journal of Financial Research*, 43(3), 459-489.
- Hossain, A., Saadi, S., & Amin, A. S. (2022). Does CEO risk-aversion affect carbon emission? *Journal of Business Ethics*, 1-28. <https://doi.org/10.1007/s10551-21-05031-8>.
- Hossain, A. T., & Masum, A. A. (2022). Does corporate social responsibility help mitigate firm-level climate change risk? *Finance Research Letters*, 47, 102791.
- Huynh, T. D., Nguyen, T. H., & Truong, C. (2020). Climate risk: The price of drought. *Journal of Corporate Finance*, 65, 101750.
- Huynh, T. D., & Xia, Y. (2021). Climate change news risk and corporate bond returns. *Journal of Financial and Quantitative Analysis*, 56(6), 1985-2009.
- Javadi, S., & Masum, A. A. (2021). The impact of climate change on the cost of bank loans. *Journal of Corporate Finance*, 69(8), 102019.

- Javadi, S., Masum, A. A., Mollagholamali, M., & Rao, R. P. (2022). *Climate Change and Corporate Cash Holdings: Global Evidence*. Available at <https://ssrn.com/abstract=3717092>.
- Jayaraman, S., & Milbourn, T. (2015). CEO equity incentives and financial misreporting: The role of auditor expertise. *The Accounting Review*, 90(1), 321-350.
- Jensen, M. C. (1986). Agency costs of free cash flow, corporate finance, and takeovers. *American Economic Review*, 76(2), 323-329.
- Jensen, M. C. (1993). The modern industrial revolution, exit, and the failure of internal control systems. *The Journal of Finance*, 48(3), 831-880.
- Jensen, M. C., & Meckling, W. H. (1976). Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of Financial Economics*, 3(4), 305-360.
- Jensen, M. C., & Murphy, K. J. (1990). Performance pay and top-management incentives. *Journal of Political Economy*, 98(2), 225-264.
- Jha, A., & Chen, Y. (2015). Audit fees and social capital. *The Accounting Review*, 90(2), 611-639.
- Jha, A., & Cox, J. (2015). Corporate social responsibility and social capital. *Journal of Banking & Finance*, 60, 252-270.
- Jiao, Y. (2010). Stakeholder welfare and firm value. *Journal of Banking & Finance*, 34(10), 2549-2561.
- Jin, L. (2002). CEO compensation, diversification, and incentives. *Journal of Financial Economics*, 66(1), 29-63.
- Joakim, S., & Andersson, A. (2022). CEO Pay and the Argument from Peer Comparison. *Journal of Business Ethics*, 175(4), 759-771.
- John, T. A., & John, K. (1993). Top-management compensation and capital structure. *The Journal of Finance*, 48(3), 949-974.
- Kaplan, S. N., & Zingales, L. (1997). Do investment-cash flow sensitivities provide useful measures of financing constraints? *The Quarterly Journal of Economics*, 112(1), 169-215.
- Kelly, D. L., & Kolstad, C. D. (1999). Bayesian learning, growth, and pollution. *Journal of Economic Dynamics and Control*, 23(4), 491-518.
- Kim, J. B., Li, Y., & Zhang, L. (2011). CFOs versus CEOs: Equity incentives and crashes. *Journal of Financial Economics*, 101(3), 713-730.
- Kim, Y., Li, H., & Li, S. (2015). CEO Equity Incentives and Audit Fees. *Contemporary Accounting Research*, 32(2), 608-638.
- Kolstad, C. D. (1992). Looking vs. leaping: the timing of CO₂ control in the face of uncertainty and learning. In Y. Kaya, N. Nakićenović, W. D. Nordhaus, & F. L. Toth (Eds.), *Costs, Impacts, and Benefits of CO₂ Mitigation* (pp. 63-82). International Institute for Applied Systems Analysis.
- Krueger, P., Sautner, Z., & Starks, L. T. (2020). The importance of climate risks for institutional investors. *The Review of Financial Studies*, 33(3), 1067-1111.
- Laux, V. (2008). Board independence and CEO turnover. *Journal of Accounting Research*, 46(1), 137-171.
- Levy, R. E. (2021). Social media, news consumption, and polarization: Evidence from a field experiment. *American Economic Review*, 111(3), 831-70.
- Lie, E. (2005). On the timing of CEO stock option awards. *Management Science*, 51(5), 802-812.
- Lins, K. V., Servaes, H., & Tamayo, A. (2017). Social capital, trust, and firm performance: The value of corporate social responsibility during the financial crisis. *The Journal of Finance*, 72(4), 1785-1824.
- Loughran, T., & Ritter, J. (2004). Why has IPO underpricing changed over time?. *Financial Management*, 33(3), 5-37.
- Marquis, Christopher, Michael W. Toffel, and Yanhua Zhou. (2016). "Scrutiny, norms, and selective disclosure: A global study of greenwashing." *Organization Science*, 27(2) 483-504.
- Masulis, R. W., Wang, C., & Xie, F. (2007). Corporate governance and acquirer returns. *The Journal of Finance*, 62(4), 1851-1889.

- Matsumura, E. M., Prakash, R., & Vera-Munoz, S. C. (2014). Firm-value effects of carbon emissions and carbon disclosures. *The Accounting Review*, 89(2), 695-724.
- McConnell, J. J., & Servaes, H. (1990). Additional evidence on equity ownership and corporate value. *Journal of Financial Economics*, 27(2), 595-612.
- McMullin, J. L., & Schonberger, B. (2020). Entropy-balanced accruals. *Review of Accounting Studies*, 25(1), 84-119.
- Mehran, H. (1995). Executive compensation structure, ownership, and firm performance. *Journal of Financial Economics*, 38(2), 163-184.
- Mian, A., & Sufi, A. (2014). What explains the 2007–2009 drop in employment? *Econometrica*, 82(6), 2197-2223.
- Mishra, C. S., & Nielsen, J. F. (2000). Board independence and compensation policies in large bank holding companies. *Financial Management*, 29(3), 51-69.
- Morck, R., Shleifer, A., & Vishny, R. W. (1988). Management ownership and market valuation: An empirical analysis. *Journal of Financial Economics*, 20(Jan.-March), 293-315.
- Morse, A., Nanda, V., & Seru, A. (2011). Are incentive contracts rigged by powerful CEOs?. *The Journal of Finance*, 66(5), 1779-1821.
- Murphy, K. J. (1999). Executive compensation. *Handbook of Labor Economics* (Vol. 3, pp. 2485-2563). North-Holland.
- Murphy, K. J. (2013). Executive compensation: Where we are, and how we got there. In *Handbook of the Economics of Finance* (Vol. 2, pp. 211-356). Elsevier.
- Murphy, K. J., & Zbojnik, J. (2004). CEO pay and appointments: A market-based explanation for recent trends. *American economic review*, 94(2), 192-196.
- Nguyen, J. H., & Phan, H. V. (2020). Carbon risk and corporate capital structure. *Journal of Corporate Finance*, 64, 101713.
- Nordhaus, W. D. (1977). Economic growth and climate: the carbon dioxide problem. *The American Economic Review*, 67(1), 341-346.
- Nordhaus, W. D., & Popp, D. (1997). What is the value of scientific knowledge? An application to global warming using the PRICE model. *The Energy Journal*, 18(1), 1-45.
- Ohlson, J. A., & Juettner-Nauroth, B. E. (2005). Expected EPS and EPS growth as determinants of value. *Review of Accounting Studies*, 10(2), 349-365.
- Oster, E. (2019). Unobservable selection and coefficient stability: Theory and evidence. *Journal of Business & Economic Statistics*, 37(2), 187-204.
- Oyer, P., & Schaefer, S. (2005). Why do some firms give stock options to all employees?: An empirical examination of alternative theories. *Journal of Financial Economics*, 76(1), 99-133.
- Ozerturk, S. (2005). Board independence and CEO pay. *Economics Letters*, 88(2), 260-265.
- Painter, M. (2020). An inconvenient cost: The effects of climate change on municipal bonds. *Journal of Financial Economics*, 135(2), 468-482.
- Pástor, L., Sinha, M., & Swaminathan, B. (2008). Estimating the intertemporal risk–return tradeoff using the implied cost of capital. *The Journal of Finance*, 63(6), 2859-2897.
- Pizzetti, M., Gatti, L., & Seele, P. (2021). Firms Talk, suppliers walk: Analyzing the locus of greenwashing in the blame game and introducing ‘vicarious greenwashing’. *Journal of Business Ethics*, 170(1), 21-38.
- Prevost, A. K., Devos, E., & Rao, R. P. (2013). The effects of relative changes in CEO equity incentives on the cost of corporate debt. *Journal of Business Finance & Accounting*, 40(3-4), 470-500.
- Qu, X., Yao, D., & Percy, M. (2020). How the design of CEO equity-based compensation can lead to lower audit fees: evidence from Australia. *Journal of Business Ethics*, 163(2), 281-308.
- Reid, E. M., & Toffel, M. W. (2009). Responding to public and private politics: Corporate disclosure of climate change strategies. *Strategic Management Journal*, 30(11), 1157-1178.

- Ringquist, E. J. (1993). Does regulation matter? Evaluating the effects of state air pollution control programs. *The Journal of Politics*, 55(4), 1022-1045.
- Rosenbaum, P. R., & Rubin, D. B. (1983). The central role of the propensity score in observational studies for causal effects. *Biometrika*, 70(1), 41-55.
- Ryan Jr., H. E., & Wiggins III, R. A. (2004). Who is in whose pocket? Director compensation, board independence, and barriers to effective monitoring. *Journal of Financial Economics*, 73(3), 497-524.
- Sandberg, J., & Andersson, A. (2020). CEO Pay and the Argument from Peer Comparison. *Journal of Business Ethics*, 175(4), 1-13.
- Sautner, Z., van Lent, L., Vilkov, G., & Zhang, R. (2022). Firm-level climate change exposure. *The Journal of Finance*, forthcoming.
- Shipman, J. E., Swanquist, Q. T., & Whited, R. L. (2017). Propensity score matching in accounting research. *The Accounting Review*, 92(1), 213-244.
- Smith, A. (1776). *An Inquiry into the Nature and Causes of the Wealth of Nations*. (Vol. 1). W. Strahan and T. Cadell.
- Smith, J. D. (2016). US political corruption and firm financial policies. *Journal of Financial Economics*, 121(2), 350-367.
- Stern, N. (2008). The economics of climate change. *American Economic Review*, 98(2), 1-37.
- Vergne, J. P., Wernicke, G., & Brenner, S. (2018). Signal incongruence and its consequences: A study of media disapproval and CEO overcompensation. *Organization Science*, 29(5), 796-817.
- Villalonga, B., & Amit, R. (2006). How do family ownership, control and management affect firm value? *Journal of Financial Economics*, 80(2), 385-417.
- Wu, M. W., & Shen, C. H. (2013). Corporate social responsibility in the banking industry: Motives and financial performance. *Journal of Banking & Finance*, 37(9), 3529-3547.
- Wu, N., Xiao, W., Liu, W., & Zhang, Z. (2022). Corporate climate risk and stock market reaction to performance briefings in China. *Environmental Science and Pollution Research*, 1-20. <https://doi.org/10.1007/s11356-022-19479-2>
- Yermack, D. (1997). Good timing: CEO stock option awards and company news announcements. *The Journal of Finance*, 52(2), 449-476.
- Zhang, D. (2022). Green financial system regulation shock and greenwashing behaviors: Evidence from Chinese firms. *Energy Economics*, 111, 106064.

Table 1
Variable Definitions

Variables	Description
<i>Incentive pay</i>	Logarithm of one plus equity-based compensation as reported in ExecuComp in a given year (see Hoi et al., 2019)
<i>Pay ratio</i>	Ratio of incentive pay to total pay for a given year.
<i>Climate risk</i>	Firm-level climate risk as calculated in Sautner et al. (2022). Detail is provided in Section 3.3 of the main text.
<i>CEO age</i>	Age of the CEO in year t.
<i>CEO tenure</i>	Number of year the current CEO has been in his/her position.
<i>IO concentration</i>	Sum of the squares of the fraction of shares held by each institutional owner.
<i>IO total</i>	Fraction of a firm's shares held by institutional owners.
<i>Firm size</i>	Logarithm of total assets of a firm in year t.
<i>Return</i>	Average monthly return for a stock for the preceding year
<i>Return volatility</i>	Standard return of those monthly returns.
<i>ROA</i>	Return on assets for a firm for year t.
<i>M/B</i>	Market value of equity to book value of equity.
<i>Leverage</i>	Ratio of total liabilities (DLC+DLTT) to total assets.
<i>Cash</i>	Ratio of cash and cash equivalents scaled by total assets.
<i>CAPEX</i>	Ratio of capital expenditure scaled by total assets.

Table 2
Sample Distribution

Industry	Freq.	Percent	Cum.	Equity pay (\$000s)	Climate risk
Consumer Non-Durables	827	5.53	5.53	4,070.0	0.006
Consumer Durables	388	2.60	8.13	3,385.7	0.040
Manufacturing	1,955	13.08	21.21	3,509.3	0.037
Energy	494	3.31	24.52	4,180.9	0.025
Chemicals	557	3.73	28.24	5,026.3	0.039
Business Equipment	3,164	21.17	49.41	3,652.4	0.022
Telecom	107	0.72	50.13	4,863.2	0.012
Utilities	627	4.20	54.33	5,391.9	0.285
Shops (Retail)	1,846	12.35	66.68	3,083.6	0.007
Healthcare	1,422	9.51	76.19	3,999.2	0.009
Finance	1,692	11.32	87.51	3,989.7	0.021
Other	1,866	12.49	100.00	3,442.3	0.028
Total	14,945	100.00		3,774.9	0.033

Table 3
Descriptive Statistics

Variable	N	Mean	S.D.	p25	Median	p75
<i>Incentive pay</i>	14,945	5.81	3.56	0.00	7.23	8.39
<i>Pay ratio</i>	14,945	0.61	0.96	0.00	0.42	0.78
<i>Climate risk</i>	14,945	0.03	0.17	0.00	0.00	0.00
<i>CEO age</i>	14,945	56.03	7.20	51.00	56.00	61.00
<i>CEO tenure</i>	14,945	7.54	7.18	2.00	5.00	11.00
<i>IO concentration</i>	14,945	0.05	0.03	0.04	0.05	0.06
<i>IO total</i>	14,945	0.79	0.18	0.69	0.82	0.92
<i>Firm size</i>	14,945	7.51	1.54	6.38	7.43	8.53
<i>Return</i>	14,945	0.01	0.03	0.00	0.01	0.03
<i>Return volatility</i>	14,945	0.10	0.05	0.06	0.09	0.12
<i>ROA</i>	14,945	0.15	0.18	0.08	0.13	0.18
<i>M/B</i>	14,945	3.32	3.38	1.52	2.31	3.75
<i>Leverage</i>	14,945	0.20	0.18	0.03	0.19	0.33
<i>Cash</i>	14,945	0.16	0.17	0.03	0.10	0.24
<i>CAPEX</i>	14,945	0.04	0.05	0.01	0.03	0.06
<i>Equity pay (\$000s)</i>	14,945	3,774.9	6,181.7	0.0	1,372.3	4,401.4
<i>Total pay (\$000s)</i>	14,945	5,083.0	4,599.6	1,879.0	3,717.5	6,716.1
<i>Cash pay (\$000s)</i>	14,945	771.6	313.3	545.8	750.0	975.0
<i>Other pay (\$000s)</i>	14,945	171.2	376.9	15.6	53.3	162.8
<i>Bonus pay (\$000s)</i>	14,945	212.4	560.4	0.0	0.0	48.0

Notes: This table reports descriptive statistics of our main model variables. Our sample consists of 14,945 firm year observations over the period 2002 to 2018. The variable definitions are provided in Table 1. All continuous control variables are winsorized at the 1%/99% levels.

Table 4
Pearson Correlation

No.	Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	<i>Incentive pay</i>	1														
2	<i>Pay ratio</i>	0.847***	1													
3	<i>Climate risk</i>	0.041***	0.055***	1												
4	<i>CEO age</i>	-0.068***	-0.077***	0.019**	1											
5	<i>CEO tenure</i>	-0.144***	-0.119***	-0.001	0.391***	1										
6	<i>IO concentration</i>	-0.195***	-0.172***	0.005	-0.027***	0.01	1									
7	<i>IO total</i>	0.125***	0.107***	-0.061***	-0.043***	-0.048***	-0.325***	1								
8	<i>Firm size</i>	0.325***	0.284***	0.067***	0.092***	-0.084***	-0.334***	0.039***	1							
9	<i>Return</i>	0.017**	0.022***	-0.001	-0.009	0.01	0.043***	0.018**	-0.067***	1						
10	<i>Return volatility</i>	-0.130***	-0.125***	-0.059***	-0.085***	0.018**	0.215***	-0.098***	-0.383***	0.080***	1					
11	<i>ROA</i>	0.019**	0.031***	-0.030***	0.000	-0.001	-0.078***	0.100***	0.041***	0.045***	-0.176***	1				
12	<i>M/B</i>	0.069***	0.085***	-0.043***	-0.066***	-0.016**	-0.017**	0.039***	-0.056***	0.204***	-0.054***	0.113***	1			
13	<i>Leverage</i>	0.125***	0.102***	0.043***	0.041***	-0.064***	-0.034***	0.040***	0.359***	-0.053***	-0.096***	0.183***	0.112***	1		
14	<i>Cash</i>	-0.064***	-0.039***	-0.064***	-0.108***	0.060***	0.094***	0.013	-0.404***	0.090***	0.244***	-0.131***	0.205***	-0.430***	1	
15	<i>CAPEX</i>	-0.004	-0.005	0.034***	-0.005	-0.005	-0.057***	0.035***	-0.041***	-0.031***	0.049***	-0.002	0.041***	0.014*	-0.133***	1

Notes: This table reports the Pearson Correlations among the regression variables in our study. Definitions of all variables are provided in Table 1. All continuous control variables are winsorized at the 1%/99% levels. *, **, and *** refer to 10%, 5%, and 1% levels of significance, respectively.

Table 5
Baseline results

Panel A: Main model specification

Variables	Expected Sign	<i>DV = Incentive pay</i>	<i>DV = Pay ratio</i>
		(1)	(2)
<i>Climate risk</i>	+	0.3943*** (3.05)	0.0515*** (2.58)
<i>CEO age</i>	-	-0.0303*** (-3.22)	-0.0045*** (-4.30)
<i>CEO tenure</i>	-	-0.0048 (-0.47)	0.0007 (0.71)
<i>IO concentration</i>	-	-1.9944 (-1.39)	-0.3672** (-2.32)
<i>IO total</i>	+	0.3075 (0.97)	0.0585* (1.71)
<i>Firm size</i>	+	0.3802*** (3.69)	0.0091 (0.76)
<i>Return</i>	+	2.6370*** (3.08)	0.2919*** (3.37)
<i>Return volatility</i>	+/-	0.6529 (0.97)	0.1912** (2.57)
<i>ROA</i>	+	0.6340 (1.29)	0.0487 (0.94)
<i>M/B</i>	+	0.0377** (2.42)	0.0048*** (2.82)
<i>Leverage</i>	-	-1.0397** (-2.50)	-0.0709 (-1.51)
<i>Cash</i>	+	0.0195 (0.04)	0.0581 (1.24)
<i>CAPEX</i>	+	2.7771** (2.19)	0.2960** (2.20)
<i>Constant</i>		4.3045*** (4.55)	0.5439*** (4.99)
Observations		14,945	14,945
R-squared		0.530	0.495
Firm FE		yes	yes
Year FE		yes	yes
Cluster		firm	firm

Panel B: Use of alternate model specifications

Variables	<i>DV = Incentive pay</i>		<i>DV = Pay ratio</i>	
	(1)	(2)	(3)	(4)
	<i>Industry FE</i>	<i>HD FE</i>	<i>Industry FE</i>	<i>HD FE</i>
<i>Climate risk</i>	0.5127*** (3.86)	0.3048*** (2.58)	0.0749*** (4.14)	0.0350* (1.74)
<i>CEO age</i>	-0.0266*** (-3.11)	-0.0325*** (-3.47)	-0.0039*** (-4.72)	-0.0047*** (-4.50)
<i>CEO tenure</i>	-0.0420*** (-4.62)	-0.0022 (-0.22)	-0.0031*** (-3.61)	0.0008 (0.78)
<i>IO concentration</i>	-5.7292*** (-3.74)	-2.0163 (-1.35)	-0.6706*** (-4.39)	-0.3528** (-2.21)
<i>IO total</i>	1.6177*** (4.82)	0.5144 (1.54)	0.1251*** (3.83)	0.0818** (2.22)
<i>Firm size</i>	0.9141*** (19.58)	0.3352*** (3.03)	0.0799*** (16.01)	0.0036 (0.28)
<i>Return</i>	2.5214*** (2.67)	2.7236*** (2.98)	0.3402*** (3.59)	0.3325*** (3.56)
<i>Return volatility</i>	0.0749 (0.09)	0.2275 (0.31)	0.0538 (0.61)	0.0645 (0.80)
<i>ROA</i>	-0.2569 (-0.50)	0.4869 (0.94)	-0.0260 (-0.53)	0.0441 (0.77)
<i>M/B</i>	0.0488*** (2.70)	0.0335* (1.96)	0.0057*** (3.06)	0.0041** (2.22)
<i>Leverage</i>	-0.3343 (-0.81)	-0.7198* (-1.66)	-0.0534 (-1.29)	-0.0307 (-0.63)
<i>Cash</i>	0.9019** (2.28)	0.1708 (0.36)	0.1034*** (2.66)	0.0637 (1.30)
<i>CAPEX</i>	0.9979 (0.70)	2.2332 (1.60)	0.1254 (0.86)	0.1485 (1.03)
<i>Constant</i>	-0.5209 (-0.75)	4.6021*** (4.69)	-0.0140 (-0.20)	0.5913*** (5.29)
Observations	14,945	14,945	14,945	14,945
R-squared	0.201	0.568	0.170	0.538
Firm FE	no	yes	no	yes
Industry FE	yes	no	yes	no
Year FE	yes	no	yes	no
Industry-Year FE	no	yes	no	yes
Cluster	firm	firm	firm	firm

Notes: Panel A of this table reports our main regression results. All regressions are controlled for firm- and year fixed effects and standard errors are clustered at the firm level. Panel B of this table shows that our baseline findings (for both *Incentive pay* and *Pay ratio*) are insensitive to the use of different fixed effects. In Columns [1] and [3], we use industry fixed effects instead of firm fixed effects along with year fixed effects; and in Columns [2] and [4], we use high dimensional Industry by Year fixed effects along with firm fixed effects. Our key dependent variable across all models is firm-level climate risk (*Climate risk*). Standard errors are clustered at the firm level. Definitions of all variables are provided in Table 1 (main text). All continuous control variables are winsorized at the 1%/99% levels. *, **, and *** refer to 10%, 5%, and 1% levels of significance, respectively.

Table 6

Ruling out alternate explanations

Panel A. Dependent Variable is Incentive pay

Variables	<i>Dependent Variable = Incentive pay</i>									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	<i>KZ index</i>	<i>Altman Z</i>	<i>Textual FC</i>	<i>Social capital</i>	<i>State climate risk</i>	<i>Political leaning of state</i>	<i>State corruption</i>	<i>State enforcement</i>	<i>Board Independence</i>	<i>ALL</i>
<i>Climate risk</i>	0.3864***	0.3239**	0.4256***	0.3753***	0.3709***	0.3930***	0.3776***	0.3628***	0.3904***	0.4286**
	(2.95)	(2.17)	(2.94)	(2.72)	(2.68)	(3.04)	(2.86)	(2.78)	(3.02)	(2.56)
<i>KZ index</i>	0.0941									0.2475**
	(1.36)									(2.54)
<i>Altman Z score</i>		-0.0075								-0.0375
		(-0.48)								(-1.56)
<i>Textual financial constraint</i>			-0.0443							-0.4706
			(-0.06)							(-0.63)
<i>Social capital (state)</i>				-0.4468***						-0.6950***
				(-3.24)						(-3.59)
<i>State climate risk</i>					0.0156					0.0087
					(0.96)					(0.36)
<i>POTUS Red</i>						0.2089				0.3169
						(1.48)				(1.28)
<i>State corruption</i>							0.0280			-0.2973
							(0.40)			(-0.91)
<i>State environment enforcement</i>								0.0689		0.0644
								(1.01)		(0.76)
<i>Board Independence</i>									0.3888	-0.8798
									(0.45)	(-0.79)
<i>Other controls as in main model</i>	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	14,134	13,119	8,735	14,712	13,952	14,945	14,945	14,791	9,313	6,193
R-squared	0.526	0.522	0.546	0.532	0.531	0.530	0.530	0.530	0.549	0.585
Firm FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Cluster	firm	firm	firm	firm	firm	firm	firm	firm	firm	firm

Panel B. Dependent Variable is Pay ratio

Variables	<i>Dependent Variable = Pay ratio</i>									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	<i>KZ index</i>	<i>Altman Z</i>	<i>Textual FC</i>	<i>Social capital</i>	<i>State climate risk</i>	<i>Political leaning of state</i>	<i>State corruption</i>	<i>State enforcement</i>	<i>Board Independence</i>	<i>All</i>
<i>Climate risk</i>	0.0512** (2.55)	0.0466** (2.09)	0.0489* (1.89)	0.0470** (2.12)	0.0469** (2.24)	0.0515*** (2.58)	0.0491** (2.39)	0.0483** (2.33)	0.0539*** (2.61)	0.0477** (2.51)
<i>KZ index</i>	0.0141* (1.81)									0.0189** (2.01)
<i>Altman Z score</i>		0.0020 (1.10)								-0.0014 (-0.56)
<i>Textual financial constraint</i>			-0.0055 (-0.07)							-0.0508 (-0.58)
<i>Social capital (state)</i>				-0.0848*** (-5.22)						-0.1082*** (-4.72)
<i>State climate risk</i>					0.0012 (0.69)					-0.0011 (-0.42)
<i>POTUS Red</i>						0.0016 (0.10)				0.0242 (0.85)
<i>State corruption</i>							-0.0027 (-0.26)			-0.0519 (-1.47)
<i>State environment enforcement</i>								0.0044 (0.54)		0.0113 (1.21)
<i>Board Independence</i>									-0.0114 (-0.12)	-0.1526 (-1.34)
<i>Other controls as in main model</i>	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	14,134	13,119	8,735	14,712	13,952	14,945	14,945	14,791	9,313	6,193
R-squared	0.361	0.352	0.408	0.364	0.367	0.495	0.495	0.495	0.511	0.557
Firm FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Cluster	firm	firm	firm	firm	firm	firm	firm	firm	firm	firm

Notes: This table presents the verification of our baseline results with additional control variables that are likely influential factors (individually and collectively). The Dependent Variable (DV) in Panel A is *Incentive pay* and in Panel B is *Pay ratio*. All regressions are controlled for firm- and year fixed-effects and standard errors are clustered at the firm level. All continuous control variables are winsorized at the 1%/99% levels. *, **, and *** refer to 10%, 5%, and 1% levels of significance, respectively.

Table 7*Propensity Score Matched (PSM) Sample and Entropy Balanced (EB) Sample Regressions*

Dependent Variables=> Variables	PSM Sample		EB Sample	
	Incentive pay (1)	Pay ratio (2)	Incentive pay (3)	Pay ratio (4)
<i>Climate risk</i>	0.3261*** (2.82)	0.0336* (1.81)	0.2853** (2.30)	0.0328* (1.84)
<i>CEO age</i>	-0.0161 (-1.11)	-0.0042** (-2.40)	-0.0307*** (-2.67)	-0.0041*** (-2.98)
<i>CEO tenure</i>	-0.0117 (-0.75)	0.0014 (0.72)	-0.0114 (-0.99)	0.0000 (0.03)
<i>IO concentration</i>	-1.7111 (-0.44)	-0.0228 (-0.06)	2.2218 (0.97)	-0.0303 (-0.12)
<i>IO total</i>	0.5244 (0.83)	0.1453** (2.29)	0.7671* (1.88)	0.1112** (2.40)
<i>Firm size</i>	0.1074 (0.56)	0.0005 (0.02)	0.3433** (2.44)	0.0090 (0.54)
<i>Return</i>	2.0734 (1.09)	0.1668 (0.83)	3.0162** (2.54)	0.3659*** (2.88)
<i>Return volatility</i>	-0.2315 (-0.16)	0.0046 (0.03)	0.3893 (0.42)	0.1161 (1.06)
<i>ROA</i>	1.1991* (1.72)	0.0256 (0.29)	0.9865** (2.07)	0.0475 (0.82)
<i>M/B</i>	0.0150 (0.46)	0.0039 (1.19)	0.0169 (0.80)	0.0024 (1.21)
<i>Leverage</i>	-0.0127 (-0.02)	-0.0308 (-0.38)	-0.7736 (-1.42)	-0.0501 (-0.81)
<i>Cash</i>	-0.5917 (-0.69)	-0.0218 (-0.24)	-0.2375 (-0.41)	0.0129 (0.22)
<i>CAPEX</i>	2.1255 (0.85)	0.3543 (1.28)	4.8932*** (2.59)	0.4618** (2.22)
<i>Constant</i>	5.7048*** (3.21)	0.5623*** (2.72)	4.3172*** (3.37)	0.5214*** (3.48)
Observations	4,156	4,156	14,945	14,945
R-squared	0.645	0.600	0.558	0.529
Firm FE	yes	yes	yes	yes
Year FE	yes	yes	yes	yes
Cluster	firm	firm	firm	firm

Notes: This table reports results using Propensity Score Matched (PSM) and Entropy Balanced (EB) samples. The diagnostics of PSM sample and proof of convergence of EB sample are reported in the *Supplemental Appendix*. Definitions of all variables are provided in Table 1. All continuous control variables are winsorized at the 1%/99% levels. *, **, and *** refer to 10%, 5%, and 1% levels of significance, respectively.

Table 8

Quasi-Natural Experiments: Using Publication of Stern Report (2006) and Paris Accord Signing (2016) as Exogenous Shocks

Variables	DV=	<i>Stern Report</i> <i>Pre = 2004-5</i> <i>Post = 2007-8</i>		<i>Paris Accord</i> <i>Pre = 2014-15</i> <i>Post = 2017-18</i>	
		<i>Incentive pay</i> (1)	<i>Pay ratio</i> (2)	<i>Incentive pay</i> (3)	<i>Pay ratio</i> (4)
<i>Climate Risk x Post Stern</i>		4.0149*** (2.83)	0.2121** (1.99)		
<i>Climate Risk x Post Paris</i>				0.8558*** (2.63)	0.0867** (2.14)
<i>Climate risk</i>		-2.4798* (-1.88)	-0.0934 (-1.02)	0.6011*** (5.38)	0.1031*** (5.50)
<i>Post Stern</i>		-1.1891*** (-9.14)	-0.0361*** (-3.02)		
<i>Post Paris</i>				0.2887** (2.52)	0.0445*** (3.69)
<i>Other controls as in main model</i>		yes	yes	yes	yes
Observations		3,414	3,414	3,597	3,597
R-squared		0.154	0.102	0.172	0.158

Notes: This table reports results from our quasi-natural tests. We use two significant events (i.e., publication of the Stern Report (2006) and the signing of the Paris Accord (2016)) as exogenous shocks to climate change awareness. All regressions are controlled for firm- and year fixed-effects and standard errors are clustered at the firm level. A comprehensive discussion of this table is provided in Section 4.4.2. Definitions of all variables are provided in Table 1. All continuous control variables are winsorized at the 1%/99% levels. *, **, and *** refer to 10%, 5%, and 1% levels of significance, respectively.

Table 9: Cross-sectional tests

Panel A: Socially responsible vs. irresponsible firms

Variables	Incentive pay		Pay ratio	
	(1)	(2)	(3)	(4)
	<i>Socially responsible firms</i>	<i>Socially irresponsible firms</i>	<i>Socially responsible firms</i>	<i>Socially irresponsible firms</i>
Climate risk	0.4162*** (3.43)	0.2352 (0.80)	0.0524*** (2.64)	0.0264 (0.84)
<i>Other controls as in main model</i>	yes	yes	yes	yes
Observations	9,478	5,467	9,478	5,467
R-squared	0.572	0.600	0.546	0.575
Firm FE	yes	yes	yes	yes
Year FE	yes	yes	yes	yes
Cluster	firm	firm	firm	firm
prob>Chi-square	0.04		0.05	

Panel B: High vs. low environmental risk firms

Variables	Incentive pay		Pay ratio	
	(1)	(2)	(3)	(4)
	<i>High Env. Lit. Risk</i>	<i>Low Env. Lit. Risk</i>	<i>High Env. Lit. Risk</i>	<i>Low Env. Lit. Risk</i>
Climate risk	0.3211** (2.48)	0.0260 (0.90)	0.0461** (2.18)	0.0089 (0.75)
<i>Other controls as in main model</i>	yes	yes	yes	yes
Observations	6,460	8,485	6,460	8,485
R-squared	0.496	0.548	0.456	0.522
Firm FE	yes	yes	yes	yes
Year FE	yes	yes	yes	yes
Cluster	firm	firm	firm	firm
prob>Chi-square	0.05		0.00	

Panel C: High-tech vs. non-high-tech firms

Variables	Incentive pay		Pay ratio	
	(1)	(2)	(3)	(4)
	<i>High-tech firms</i>	<i>Non-high-tech firms</i>	<i>High-tech firms</i>	<i>Non-high-tech firms</i>
Climate risk	-0.1213 (-0.43)	0.4492*** (3.72)	0.0134** (2.06)	0.0480** (2.19)
<i>Other controls as in main model</i>	yes	yes	yes	yes
Observations	2,862	12,083	2,862	12,083
R-squared	0.491	0.541	0.441	0.511
Firm FE	yes	yes	yes	yes
Year FE	yes	yes	yes	yes
Cluster	firm	firm	firm	firm
prob>Chi-square	0.00		0.02	

Notes: This table reports results from our cross-sectional tests. Panel A compares results for socially responsible vs. irresponsible firms. Panel B compares results for high vs. low environmental litigation industry subsamples. Panel C compares results for high-tech vs. non-high-tech industry subsamples. All regressions are controlled for firm- and year fixed-effects and standard errors are clustered at the firm level. A comprehensive discussion of this table is provided in Section 4.5. Definitions of all variables are provided in Table 1. All continuous control variables are winsorized at the 1%/99% levels. *, **, and *** refer to 10%, 5%, and 1% levels of significance, respectively.

Table 10

Consequence Test

Panel A: Climate change risk, CEO pay, and implied cost of capital

Variables	<i>DV = ICC_{OJN}</i>		<i>DV = ICC_{MPEG}</i>	
	(1)	(2)	(1)	(2)
<i>Climate risk * High Incentive Pay</i>	-0.8652** (-2.29)		-0.9849* (-1.89)	
<i>Climate risk * High Pay ratio</i>		-0.8171** (-1.98)		-0.9703* (-1.71)
<i>Climate risk</i>	0.7418* (1.87)	0.6933* (1.83)	0.6983** (2.05)	0.6749** (2.06)
High Incentive pay	-0.0281 (-0.41)		-0.0937 (-0.94)	
<i>High Pay ratio</i>		-0.0139 (-0.22)		-0.0442 (-0.49)
<i>Firm size</i>	-0.5154*** (-4.36)	-0.5194*** (-4.39)	-0.9680*** (-5.70)	-0.9775*** (-5.76)
<i>Leverage</i>	3.1862*** (7.78)	3.1968*** (7.80)	4.3469*** (7.11)	4.3641*** (7.14)
<i>M/B</i>	-0.1145*** (-6.36)	-0.1148*** (-6.37)	-0.1314*** (-5.84)	-0.1318*** (-5.84)
<i>Return</i>	-1.5034* (-1.82)	-1.4941* (-1.81)	-1.0965 (-0.87)	-1.0784 (-0.85)
<i>Return volatility</i>	3.8987*** (3.66)	3.8846*** (3.66)	5.8694*** (3.68)	5.8322*** (3.67)
<i>ROA</i>	1.3318** (2.23)	1.3221** (2.21)	-1.1628 (-1.27)	-1.1855 (-1.29)
Long term growth	0.0209*** (3.49)	0.0209*** (3.49)	0.0108 (1.33)	0.0108 (1.33)
Dispersion	1.4707** (2.45)	1.4784** (2.46)	1.5261* (1.70)	1.5406* (1.71)
Stock beta	0.1869** (2.05)	0.1873** (2.06)	0.4205*** (3.15)	0.4212*** (3.16)
<i>Constant</i>	13.9610*** (14.90)	13.9831*** (14.92)	17.6016*** (13.14)	17.6466*** (13.17)
Observations	10,148	10,148	10,148	10,148
R-squared	0.555	0.555	0.470	0.470
Firm FE	yes	yes	yes	yes
Year FE	yes	yes	yes	yes
Cluster	firm	firm	firm	firm

Panel B: Climate change risk, CEO pay, and long-term firm value

Variables	<i>DV = Tobin's Q</i>		<i>DV = Industry adjusted Q</i>	
	(1)	(2)	(1)	(2)
<i>Climate risk * High Incentive Pay</i>	0.1794** (2.34)		0.1702** (2.44)	
<i>Climate risk * High Pay ratio</i>		0.2047*** (2.97)		0.1663*** (2.69)
<i>Climate risk</i>	-0.1864** (-2.31)	-0.2141*** (-2.83)	-0.1607** (-2.22)	-0.1536** (-2.30)
High Incentive pay	0.1145*** (5.09)		0.1083*** (5.04)	
<i>High Pay ratio</i>		0.0722*** (3.55)		0.0658*** (3.41)
<i>Firm size</i>	-0.3155*** (-6.92)	-0.3072*** (-6.75)	-0.3253*** (-7.00)	-0.3174*** (-6.84)
<i>Leverage</i>	-0.9977*** (-7.22)	-1.0110*** (-7.32)	-0.9932*** (-7.34)	-1.0062*** (-7.42)
Stock beta	0.0254 (0.86)	0.0245 (0.82)	0.0339 (1.14)	0.0332 (1.11)
<i>CAPEX</i>	3.1052*** (7.03)	3.1355*** (7.07)	2.4103*** (5.80)	2.4368*** (5.84)
<i>R&D</i>	0.1764 (0.16)	0.2015 (0.18)	0.4281 (0.39)	0.4538 (0.41)
Long term growth	0.0191*** (11.64)	0.0191*** (11.65)	0.0169*** (10.93)	0.0170*** (10.92)
Dividend	6.0461*** (4.51)	5.9878*** (4.46)	5.7562*** (4.43)	5.7029*** (4.38)
<i>Constant</i>	4.0337*** (11.38)	3.9942*** (11.23)	2.4429*** (6.82)	2.4066*** (6.70)
Observations	12,154	12,154	12,154	12,154
R-squared	0.749	0.748	0.704	0.703
Firm FE	yes	yes	yes	yes
Year FE	yes	yes	yes	yes
Cluster	firm	firm	firm	firm

Notes: This table reports results from our additional analysis described in Section 5. All regressions are controlled for firm- and year fixed-effects and standard errors are clustered at the firm level. Definitions of all variables are provided in Table 1. All continuous control variables are winsorized at the 1%/99% levels. *, **, and *** refer to 10%, 5%, and 1% levels of significance, respectively.