# Green Moral Hazard: Estimating the Financial and the Real Implications of CEO Incentives

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June 7, 2026

**Abstract**

I develop a novel structural model and quantify the financial and the real implications of CEO compensation contracts with incentives tied to real, environmental outcomes. In terms of the direct tradeoff in the absence of agency friction, I find that the incentives motivate CEOs to reduce carbon emission intensity by 1.8% per year but at a financial cost of 1.3% of firm value annually. Moral hazard makes the environmental improvement even more costly. As green performance is an imperfect signal of CEOs' actions toward green outcomes, a "green moral hazard" arises: the CEOs require a premium for the risk added by green incentives. I estimate that this green moral hazard is substantial, accounting for $1.72 million of the total moral hazard cost of $2.05 million. These results suggest that green incentives pose an important economic trade-off: while green incentives can lead to meaningful environmental improvements, they impose substantial costs on the firm.

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I am grateful to Ivan Marinovic, Maureen McNichols, Kevin Smith, Peter Reiss, and Colleen Honigsberg for their invaluable guidance. I also thank Robert Miller, Johannes Stroebel, Robert Engle, Jeffrey Wurgler, Lin Peng, Nadya Malenko, Janet Gao, Alvin Chen, Anastasia Zakolyukina, Tim Baldenius, Hans Christensen, Ilan Guttman, Kose John, Stefan Reichelstein, Anne Beyer, Jungho Choi, Ed deHaan, John Kepler, Christopher Armstrong, Brandon Gipper, Suzie Noh, Sara Malik, Hao Xue, Lin Qiu, and seminar participants at the European Finance Association Annual Meeting, Conference in Sustainable Finance by the University of Luxembourg, NYU Climate Finance Conference, New York University Stern, Carnegie Melon University Tepper, Accounting and Economics Society Junior Accounting Theory Conference, American Accounting Association Doctoral Consortium, Stanford Accounting Brown Bag, and the Stanford Corporate Finance Reading Group for their helpful comments. All errors are my own.

# 1 Introduction

Firms increasingly expect CEOs to deliver on multiple objectives: to improve financial performance while also improving real outcomes, such as reducing carbon emissions, ensuring product safety, or enhancing data security. These real outcomes often require costly investments or operational adjustments that affect financial results. Designing compensation in this setting creates a fundamental contracting trade-off: how to motivate costly real actions while maintaining incentives for financial performance. This trade-off involves substantial agency friction, which makes improving real outcomes even more costly.

Understanding this trade-off between financial performance and real outcomes is important because it informs how firms, investors, and policymakers design incentives for costly real-outcome actions. Quantifying the trade-off helps guide corporate and regulatory policies and allows investors to assess how well a firm's incentive structures align with the value they place on real outcomes. It is also important to understand the agency friction behind this trade-off: moral hazard has been a classic problem in corporate finance, yet little is known about the extent of moral hazard associated with real actions.

Despite the importance, it is challenging to quantify the trade-off incentivized by such contracts, because the CEO's underlying actions are inherently unobservable and real-outcome metrics used in contracts are noisy proxies for effort. As a result, the observed outcomes reflect two distinct forces: (i) the direct cost of improvement in the real outcome, and (ii) the additional incentive cost created by measurement noise in the real-outcome metrics. Separating these forces requires a structural approach.

In this paper, I develop and estimate a structural model of CEO incentives designed to achieve both financial and real objectives. I apply the model to analyze green incentives, compensation provisions tied to reductions in carbon emissions. I find that green incentives induce CEOs to meaningfully improve firms' environmental performance, but at a substantial financial cost. Reducing carbon-emission intensity by 1.8% requires firms to forgo roughly 1.3% of firm value—about one-quarter of the value created by CEOs' financial efforts—and accounts for nearly 60% of the total emissions reductions these firms achieve. The mechanism involves sizable incentive costs: the cost of green moral hazard is about \$1.72 million (over 7% of annual CEO pay), far exceeding the cost of financial moral hazard (under \$0.4 million). This paper is among the first, to my knowledge, to develop a structural model and quantify the important economic trade-off associated with incentives for real outcomes and to show that the agency cost associated specifically with those incentives is substantial.

I focus on the green dimension, due to its rapidly increasing prevalence and prominence in executive compensation over the past decade. Even if this trend reverses, understanding the trade-off remains important for firms and policymakers, because reducing or removing such incentives would involve the same economic trade-off in the opposite direction.

Without a structural model, examining what incentives for real outcomes incentivize at what cost faces major challenges. First, the adoption of such incentives in compensation contracts is an inherently endogenous decision. The decision would depend heavily on the trade-offs between financial and real outcomes, one cannot use the outcomes of firms that do not offer incentives for real outcomes as proper counterfactuals. Second, moral hazard is challenging to quantify without analyzing the counterfactual case in which information asymmetry is absent. Observing this counterfactual case would be even more difficult, as it requires the resolution of the moral hazard problem itself. By taking a structural approach that allows for estimating the counterfactual outcome distribution directly from the wage function and analyzing counterfactual cases where information asymmetry is absent, I address the challenges mentioned above.

The structural model is designed for two goals: (1) estimating the extent to which compensation contracts incentivize managers to invest in improving firms' real outcomes and (2) quantifying the economic magnitude of the moral hazard problem associated with such incentives. I start by modeling the problem of a principal designing an optimal compensation contract with the objective that depends on both financial and real outcomes. Then, I take this model to the data of realized performance outcomes and compensations for firms that incorporate incentives for real outcomes. The structural estimation uncovers the underlying parameters including the cost of effort and the value of outside option for the CEOs, as well as the distribution of outcomes in the absence of incentives for financial and real outcomes. With these estimates, I perform counterfactual analyses to quantify the extent of moral hazard associated with each incentive.

In my model, the principal designs a contract with an agent that can perform two types of actions that impact the distribution of the principal's value. The principal cannot observe the agent's action choice but only the realized outcomes, the joint distribution of which varies by the agent's actions. The key feature of this model is that it allows me to separately identify the financial and real implications of projects to improve real outcomes from that of the agent's personally costly effort to improve financial performance. The intuition behind this is a lá Holmström (1979) that one can infer the likelihood ratios of outcome distributions across different actions by the agent, directly from the wage function. In other words, one can learn about the counterfactual outcome distributions, had the agent either shirked on financial effort or avoided the project to improve real outcomes, from the observed compensation.

To take my model to the data, I merge datasets from Executive Compensation Analytics (ECA), Execucomp, Trucost, CRSP, and Compustat to construct a firm-year panel of compensation, financial performance, and environmental performance covering over 600 U.S. firms from 2012 to 2022. To measure the impact of incentives for real outcomes, I confine my main analyses to firms that explicitly include non-financial metrics in their compensation contracts. I use abnormal stock return as a measure of financial performance, which is a common approach in the literature. For the measure of green performance, I use log reduction in carbon emission intensity to control for effects driven by firm size and prior level of emission.

The structural estimation is then applied to the constructed data set. The estimation process is as follows. First, I non-parametrically estimate the joint distribution of financial and green outcomes and the wage function from the sample. Then, I estimate the parameters with moments computed from the estimated distribution and the wage function. Finally, based on the parameters, I infer the counterfactual distributions had the CEO either shirked financial effort or rejected the real-outcome project, from the wage function.

With the parameters estimated from the structural estimation, I quantify the extent of moral hazard and decompose it for each action: the financial effort and the real-outcome project decision. Specifically, I infer what the optimal contract would have been had one of the actions by the CEO been observable, in order to decompose the wage we observe in practice into three components: (1) first-best wage, which compensates for participation in the contract, (2) cost of financial moral hazard, which is the cost of incentivizing unobservable financial effort, and (3) cost of green moral hazard, which is the cost of incentivizing unobservable action to improve real outcomes on top of financial effort.

As a result of the estimation, I find that firms are willing to compromise substantial financial value to improve their green performance: to reduce carbon intensity by around 1.8%, firms are willing to forgo approximately 1.3% of stock return. These estimates are both statistically and economically significant. On the financial side, a 1.3% loss of firm value amounts to roughly a quarter of the value that CEOs create for the firms through their productive efforts. On the real, environmental side, a 1.8% reduction in carbon intensity corresponds to approximately 60% of the total reduction achieved by these firms. Therefore, my finding suggests that incentives for real outcomes play an important role in incentivizing improvements in real outcomes, at a substantial cost to the firm. To the extent that the stock market efficiently prices firms' environmental performance, the result is contrary to the claim that firms are paying CEOs on real outcomes only for financial gains. This result also sheds light on the willingness of these firms to compromise financial gains for improvements in real outcomes, relative to that of marginal investor in the capital market: firms are willing to forgo at least $0.74\%$ more financial value of the firm, for a percentage reduction in carbon emission intensity.

mance while also improving real outcomes, such as reducing carbon emission, ensuring product safety, or enhancing data security. These real outcomes often require costly investments or operational adjustments that affect financial results. Designing compensation in this setting creates a fundamental contracting trade-off: how to motivate costly real actions while maintaining incentives for financial performance. This trade-off would involve substantial agency friction, which makes improving real outcomes even more costly. Understanding this trade-off between financial performance and real outcomes is important because it informs how firms, investors, and policymakers design incentives for costly real-outcome actions. Quantifying the trade-off helps guide corporate and regulatory policies and allows investors to assess how well a firm's incentive structures align with the value they place on real outcomes. It is also important to understand the agency friction behind this trade-off: moral hazard has been a classic problem in corporate finance, yet little is known about the extent of moral hazard associated with real actions. Despite the importance, it is challenging to quantify the trade-off incentivized by such contracts, because the CEO's underlying actions are inherently unobservable and real-outcome metrics used in contracts are noisy proxies for effort. As a result, the observed outcome reflect two distinct forces: (i) the direct cost of improvement in the real outcome, and (ii) the additional incentive cost created by measurement noise in the real-outcome metrics. Separating these forces requires a structural approach. In this paper, I develop and estimate a structural model of CEO incentives designed to achieve both financial and real objectives. I apply the model to analyze green incentives, compensation provisions tied to reductions in carbon emissions. I find that green incentives induce CEOs to meaningfully improve firms' environmental performance, but at a substantial financial cost. Reduc- ing carbon-emission intensity by 1.8one-quarter of the value created by CEOs' financial efforts—and accounts for nearly 601 total emissions reductions these firms achieve. The mechanism involves sizable incentive costs: the cost of green moral hazard is about $1.72million(over7thecostoffinancialmoralhazard(under0.4$ million). This paper is among the first, to my knowl- edge, to develop a structural model and quantify the important economic trade-off associated with incentives for real outcomes and to show that the agency cost associated specifically with those incentives is substantial. I focus on the green dimension, due to its rapidly increasing prevalence and prominence in executive compensation over the past decade. Even if this trend reverses, understanding the trade- off remains important for firms and policymakers, because reducing or removing such incentives would involve the same economic trade-off in the opposite direction.cost of green moral hazard, which is the cost of incentivizing unobservable action to improve non-financial performance on top of financial effort.

From the counterfactual analyses, I find that incentivizing executives to invest in improving environmental performance, on top of exerting financial effort, is substantially costly: the cost of green moral hazard is estimated at approximately \$1.72 million, which is more than 7% of CEOs' annual compensation. In contrast, the cost of financial moral hazard is estimated at less than \$0.4 million, only around 1.5%. These findings suggest that the information asymmetry is more severe regarding the CEO's real-outcome project decision than the financial effort.

In addition, I conduct cross-sectional analyses to understand how the economic trade-offs associated with incentives for real outcomes vary across firm characteristics. With respect to firm size, I find that larger firms are more cost-efficient in reducing carbon emissions than smaller firms. With respect to the quality of governance, I find that the financial gain forgone for emission reductions is high across the board, while firms with stronger governance achieve substantially greater reduction in emissions. I further find that the cost of moral hazard, both green and financial, explain greater portion of compensation for firms with weaker governance than for those with stronger governance. This result adds validity to my estimates by reaffirming the well-established connection between agency friction and governance.

I also examine the robustness of my main results by using accounting income as an alternative measure of financial performance and obtain consistent results. Finally, I show that the sensitivity of the wage to green performance is *not* correlated with key firm characteristics, mitigating the concern that firm characteristics are confounding factors that drive my results.

Taken together, my findings indicate that firms are willing to compromise substantial financial gains to improve real outcomes and that a significant portion of executive compensation is devoted to inducing CEOs to execute costly real-outcome projects. Overall, my paper has important contributions: (1) I provide a structural model that estimates the impact of managerial incentives on both financial and real outcomes, (2) I offer an approach for disentangling the effects and agency costs of actions targeting real outcomes from those aimed at financial outcomes, (3) I find that green incentives drive CEOs to improve environmental performance, even at a notable cost to financial returns, (4) my results reveal that boards are more willing than investors to trade financial gains for environmental improvements, highlighting a distinct commitment to green objectives above and beyond their financial value, and (5) I show that green incentives involve severe moral hazard costs.

**Contribution to Literature** This paper is most closely related to the literature on identifying and estimating agency frictions with structural estimation. Studies such as Margiotta and Miller (2000) laid the groundwork for structurally identifying and estimating the extent of agency friction. Gayle and Miller (2009) and Gayle and Miller (2015) provide approaches for estimating the extent of both moral hazard and adverse selection. These approaches are applied in Gayle et al. (2022) to show that Sarbanes-Oxley mitigated moral hazard in executive compensation. Relatedly, Bertomeu et al. (2023a) shows that accounting information makes a substantial contribution to contracting efficiency incremental to stock price information. I contribute to this literature by providing a novel approach that can disentangle impacts on firm outcomes and the associated agency friction arising from actions to improve real outcomes from those for managerial efforts to improve financial performance.

Second, more broadly, my paper relates to the vast literature on agency theory and moral hazard. The seminal papers including Holmström (1979) and Holmstrom and Milgrom (1991), provide the foundation for my structural model. Building upon these models, I provide a structural model for analyzing moral hazards associated with contracting on real, non-financial outcomes. Early analytical works such as Sliwka (2002) and Dutta and Reichelstein (2003) focus primarily on the role of real, non-financial outcomes as leading performance indicators that can help align the incentive of a myopic agent with that of a principal maximizing long-term value. More recent works, such as Bonham and Riggs-Cragun (2024), Chaigneau and Sahuguet (2024), and Li et al. (2023) examine contracts aimed at improving real outcomes on top of profit maximization. These models provide valuable theoretical insights. My work contributes to this literature by developing a structural model that can be estimated directly from the data to yield key structural parameters, including the effect of CEO's actions on firms' financial and real outcomes without relying on a reduced-form approach.

Third, this paper contributes to the literature on the effect of managerial incentives on firm outcomes. There is an ongoing debate on the role of incentives for real outcomes and how they impact firms' financial and real outcomes.[1] One strand of literature finds an increase in firm value following improvements in real outcomes, consistent with incentivizing improvements in real outcomes as a means to maximizing firm value. (e.g., Ceccarelli et al., 2023; Flammer et al., 2019; Lins et al., 2017; Servaes and Tamayo, 2013).[2] In contrast, another strand of literature indicates that incentives for real outcomes are driven by shareholders' preference rather than its contribution to firm value, suggesting that improving real outcome is an objective on its own (e.g., Pawliczek et al., 2023; Li et al., 2023; Homroy et al., 2022). I contribute to this debate by documenting that green incentives incentivize CEOs to improve their green performance at a substantial cost to financial performance.

Fourth, my paper offers important implications for the climate finance literature studying the willingness of economic agents to forgo financial gains for improvements in environmental outcomes (i.e., greenium). Prior works have found evidence supporting significant greenium in the equity market (e.g., Pastor et al., 2022; Hsu et al., 2023; Bolton and Kacperczyk, 2023, 2021; Riedl and Smeets, 2017) and in the bond market (e.g., Zerbib, 2019; Gianfrate and Peri, 2019).[3] Compared to these papers that focus primarily on the greenium of capital market investors, I provide novel evidence that the boards of directors are more willing to forgo financial gains to improve green outcomes, *relative to* the marginal investor in the equity market.[4]

**Outline of the Paper** The remainder of the paper proceeds as follows: Section 2 provides institutional background regarding incentives for real outcomes. Section 3 describes the model and the assumptions for identification. Section 4 describes the sample and data. Section 5 develops the estimation methodology, reports the results, and offers explanations for the findings. Section 6 presents the counterfactual analyses based on the estimation results. Section 7 provides cross-sectional and

[1] See Velte (2024) and Gillan et al. (2021) for comprehensive review.

[2] On the contrary, Leonelli et al. (2024) suggest that there may be little to no financial benefit for improving real outcomes. Bratek et al. (2024) find that market may even reward weak non-financial performance.

[3] On the other hand, works including Aswani et al. (2023), Görgen et al. (2020), and Larcker and Watts (2020) do not find any premium on environmental performance.

[4] This result is consistent with Dyck et al. (2023), in terms of how the preference of the board of directors can influence firm decisions.

robustness analyses. Section 8 concludes.

# 2 Incentives for real outcomes

## 2.1 What do incentives for real outcomes look like?

I define an incentive for real outcomes as the component of compensation that varies with a real, non-financial outcome metric. In practice, incentives for real outcomes involve a wide variety of metrics, including carbon emission intensity, energy efficiency, frequency of chemical leaks, water usage, and recycling. They are assessed on either an absolute or a relative basis, scaled by the firm's past performance (target ratcheting) or concurrent performance of comparable firms in the industry (relative performance evaluation). Contrary to the skepticism that incentives for real outcomes are abstract and subjective, many firms build such incentives on concrete structures with objective and measurable metrics.[5]

A typical mapping from the metrics to compensation consists of (1) a threshold, a minimum level of performance that warrants any amount of compensation, (2) a target, the expected level of performance, and (3) a maximum, beyond which performance is no longer rewarded through compensation. For example, a company using carbon emission as the metric has the following structure. It has a threshold of 2,124 kilotons (kt), a target of 1,865 kt, and a maximum of 1,772 kt. This means that the CEO will receive a bonus for any emission below 2,124 kt, increasing up to emissions below 1,772 kt. This highlights the concreteness of the incentive structure, as well as the objectively quantifiable attributes of the incentive metrics.

[5] Maas (2018) finds that incentives for real outcomes have meaningful effect on real outcome when they are based on quantitative, hard targets.

## 2.2 Compensation Structure with Incentives for both Financial and Real Outcomes

Hardly any firm implements incentives for real outcomes without any incentives for financial performance. How do incentives for real outcomes affect compensation, combined with traditional incentives for financial performance? For illustrative purposes, I provide the compensation scheme of BP p.l.c in 2023, which consists of both non-financial metrics and financial metrics (see Figure 1). Within the target range, the compensation is linear in performance measures. Specifically, the compensation is a weighted average of real outcomes and financial (and operational) performance with weights of 30% and 70%, respectively. Two points are worth noting. First, the non-financial incentive constitutes a substantial portion (30%) of variable compensation.[6] Second, it is not trivial to meet non-financial targets; CEOs at times fail to achieve them and lose a considerable amount of bonus for such failures.[7] In this example, the second green bar in the rightmost column shows that the CEO lost 7.5% of the maximum compensation because the firm's sustainable emission reduction of 7.973 million tonnes fell short of the maximum level of 8.27 million tonnes.

Since most firms do not fully disclose the compensation scheme as shown in this example, systemic data on weights on each performance measure are not available. However, using data on compensation and performance measures, financial performance and non-financial performance, I verify that compensations are significantly sensitive to each performance measure, which is what matters for my analysis (see subsection 4.2 for more details).

My structural model and estimation approach are designed to be comprehensive, allowing for multiple aspects of incentives for real outcomes and outcomes, discussed above. For practical estimation, however, it is necessary to anchor on a consistent dimension. Therefore, I illustrate its

[6] Beyond this one example, I find that the compensation is significantly sensitive to non-financial performance in my sample of firms that explicitly offer incentives for real outcomes. This result seems contrary to the findings of Walker (2022). However, this divergence arises from the inclusion of changes in the values of CEO's stocks and options, which is a component of compensation that the paper points to as the potential source of incentive power on non-financial metrics.

[7] Badawi and Bartlett (2024) point out that targets may be set at levels that can easily be attained by CEOs. However, this is not a concern in the context of this paper, as incentive regions extend well beyond the "easy" targets. Ioannou et al. (2016) suggest that setting excessively difficult targets can negatively impact the completion of the target.

**2023 annual bonus scorecard and outcome**

For 2023, the committee assessed performance against a bonus scorecard of seven measures across three categories: safety and sustainability, operations and financials. These measures align with our strategy (see page 12) and were set out under the terms of our 2023 policy.

| Safety and sustainability | | Operations | | Financials | | Formulaic score |
|---|---|---|---|---|---|---|
| 0.41 | + | 0.24 | + | 0.99 | = | 1.64 out of 2.0 |

| Measures | | Weighting | Threshold (0) | Target (1) | Maximum (2) | Outcome |
|---|---|---|---|---|---|---|
| Safety and sustainability (30% weight) | Tier 1 process safety events★ | 15% | 12<br>0 | 10<br>0.075 | 8<br>0.15 | 39 (tier 1: 9, tier 2: 30)<br>0.26 |
| | Tier 2 process safety events★ | | 47<br>0 | 39<br>0.075 | 31<br>0.15 | |
| | Sustainable emissions reductions★ (million tonnes) | 15% | <7.77<br>0 | 7.97<br>0.15 | 8.27<br>0.3 | 7.973<br>0.15 |
| Operations (20% weight) | bp-operated reliability and availability | 10% | 94.5%<br>0 | 95.5%<br>0.1 | 96.4%<br>0.2 | 95.7%<br>0.13 |
| | Convenience & EV gross margin % growth | 10% | 4%<br>0 | 10%<br>0.1 | 16%<br>0.2 | 10.6%<br>0.11 |
| Financials (50% weight) | Adjusted free cash flow★ | 25% | $12.6bn<br>0 | $13.6bn<br>0.25 | $14.6bn<br>0.5 | $15.1bn<br>0.50 |
| | Adjusted EBITDA | 25% | $40.7bn<br>0 | $42.2bn<br>0.25 | $43.7bn<br>0.5 | $43.67bn[a]<br>0.49 |
| Formulaic score | | | | | | 1.64 out of 2.0 |

Figure 1: **Compensation Structure of British Petroleum** This figure illustrates the compensation structure as a function of performance metrics, taken from the company's remuneration report. (Source: https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/investors/bp-directors-remuneration-report-2023.pdf)

application within the environmental context, particularly as this dimension has gained significant prominence, evidenced by a notable increase in firms adopting it in recent years. In the context of the model itself, incorporating a third or additional dimensions does not alter the dynamics or implications qualitatively. In the domain of estimation, incorporating more dimensions introduces the curse of dimensionality, resulting in a trade-off.

# 3 Model

Answering the research question, What trade-off do incentives for real outcomes induce between financial performance and the real outcome, involves multiple challenges. First, the adoption of such incentives in executive compensation contracts is inherently endogenous. Firms offering such incentives and firms that do not are therefore not comparable, especially in terms of tradeoff between financial and real outcomes. Second, moral hazard is challenging to quantify without analyzing the counterfactual optimal wage when information asymmetry is absent, which is very difficult to observe in practice. To address these challenges, I employ a structural approach.

In this section, I construct a conceptual framework for analyzing compensation contracts that incentivize both financial effort and a real-outcome project. I then solve the model and characterize the optimal contract.

## 3.1 Theoretical Framework and Model Setup

My conceptual framework features a simple principal-agent model, in which the agent's actions are unobservable and can only be inferred from two observable and contractible signals: financial performance and real outcomes. This setup is motivated by the fact that many firms, almost 60% by 2022, have started to explicitly include non-financial measures, on top of more traditional financial measures, in their compensation contracts.

The agent is risk-averse and therefore requires a premium on the risk coming from uncertainty in outcome realizations conditional on her actions. Given that the principal seeks to induce the agent's first-best actions under the second-best, this risk premium constitutes the cost of moral hazard to the principal, incurred due to the actions being unobservable. Information about the agent's actions in the two signals, financial performance, and real outcomes, can mitigate the cost of moral hazard by reducing the uncertainty in wage faced by the agent conditional on her actions.

My model features a pure moral hazard problem in which the agent can take multi-dimensional actions. Specifically, the agent can take two types of actions: she can (1) choose to either exert costly effort to improve the financial performance of the firm or shirk ("financial effort") and (2) choose to either accept or reject an investment project that affects both financial and real outcomes ("green project"). The model setup is summarized in Figure 2.

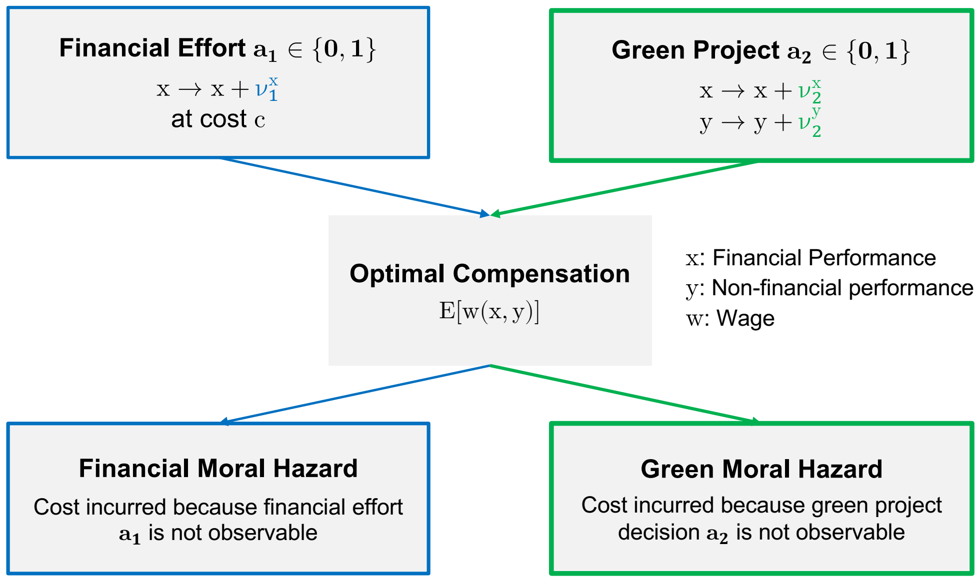



Figure 2: **Summary of Model Setup** This figure summarizes the agent's action space and the associated components of moral hazard. Parameters $\nu_1^x$, $\nu_2^x$, $\nu_2^y$ denote the financial effect of financial effort $a_1$, financial effect of green project $a_2$, and real effect of green project $a_2$, respectively.

**Principal's Problem** The principal is risk-neutral and has the objective $V(x, y)$, which is a function of both financial performance $x$ and real outcome $y$.[8] For simplicity, let the principal's objective $V(x, y)$ be a linear combination of financial outcome $x$ and real outcome $y$[9]:

$$V(x, y) = x + ky \tag{1}$$

where $k$ denotes the marginal loss in financial performance that the principal is willing to forgo for a marginal improvement in the real outcome. The principal maximizes her expected value less the expected wage to the agent:

$$\max_{w(\cdot)} \mathbb{E}[V(x, y) - w(x, y)]. \tag{2}$$

**Agent's Actions** The agent can take two types of actions: $a = (a_1, a_2)$, where $a_1$ denotes financial effort that improves financial performance and $a_2$ denotes project choice that jointly affects

[8]This is the key divergence from earlier works on non-financial performance measures including Dutta and Reichelstein (2003), where the objective is strictly firm value.

[9]Chaigneau and Sahuguet (2024) also use the same form of objective function. Bonham and Riggs-Cragun (2024) allow for a more general value function.

financial and real outcomes. As I assume a binary action space in each dimension, there are four combinations of actions: $a \in \{(0,0),(1,0),(0,1),(1,1)\}$.

Each combination of effort and investment decision yields a joint distribution $f_a(x,y)$ of the two outcomes. For tractability, I impose restrictions on how the agent's actions affect the outcome distribution. On one hand, I assume that financial effort $a_1$ only affects financial outcomes. With this assumption, I can disentangle incentives for actions that do not involve any tradeoff between financial and real outcomes. Specifically, financial effort shifts the mean of financial outcome $x$ by $\nu_1^x$ without affecting the unconditional distribution of $y$:

$$x_{11} = x_{01} + \nu_1^x \tag{3}$$

where $x_a$ denotes a level of financial outcome $x$ under effort $a$. In terms of joint density, the effect of financial effort $a_1$ can be expressed as:

$$f_{01}(x,y) = f_{11}(x+\nu_1^x, y) \tag{4}$$

On the other hand, I allow the green project decision $a_2$ to have both financial and real implications. Specifically, it shifts the means of financial outcome $x$ and real outcome $y$ by $\nu_2^x$ and $\nu_2^y$, respectively.

$$x_{11} = x_{10} + \nu_2^x \tag{5}$$

$$y_{11} = y_{10} + \nu_2^y \tag{6}$$

In terms of joint density, the effect of green project decision $a_2$ can be expressed as:

$$f_{10}(x,y) = f_{11}(x+\nu_2^x, y+\nu_2^y) \tag{7}$$

Following the standard approach in the moral hazard literature, I assume that the agent's action involves personal cost, $c_a$. Specifically, agent's action $a=(a_1,a_2)$ imposes personal cost $c_a$ to the agent, with $c_{00}$ normalized to 0. Given the nature of each decision, I assume that financial effort $a_1$ is personally costly to the agent, whereas project choice $a_2$ is not. Let $c$ denote the personal cost of financial effort. Then, effort cost can be summarized as follows:

$$c_{01} \equiv c_{00} = 0 \tag{8}$$

$$c_{11} \equiv c_{10} \equiv c \tag{9}$$

That the green project does not incur a personal cost to the agent, however, does not necessarily mean that project choice $a_2$ is not costly to the agent: as $a_2$ affects the joint distribution of $x$ and $y$, it thereby affects the distribution of wage $w(x, y)$ conditional on the choice of action.

To summarize, the financial effort is personally costly to the agent and only has financial implications, while the project decision imposes no direct cost to the agent and has both financial and real implications.

**Agent's Preference** Finally, the agent is risk-averse and has a CARA utility:

$$u(w, a) \equiv -e^{-\rho(w-c_a)} \tag{10}$$

with $c$ being the cost of effort in "dollars" and $\rho$ is risk-aversion. Let $C \equiv e^{\rho c}$ be the cost in utility. This assumption, used in a number of other structural works (Gayle and Miller (2009), Gayle and Miller (2015), Bertomeu et al. (2023a)) in the executive compensation literature, helps make the estimation feasible, as the wealth of executives is often unobservable. This also allows for dynamic implications, as shown by Holmstrom and Milgrom (1991).

**Principal's Preferred Action** I focus on contracts inducing both financial effort and project acceptance: $a^* = (1, 1)$. This decision is based on two relevant features of the data: (1) weight on non-financial outcome is positive and (2) financial performance and real outcomes are positively correlated.[10] Had the principal been using the real outcomes to induce financial effort, the weight on the real outcomes should have been negative given its positive correlation with the financial performance.[11] Therefore, contracts in practice are, on average, consistent with the incentive compatibility condition with respect to the green project being binding.

**Discussion of Model Assumptions** The assumption that the principal's value $V(x, y)$ is a linear combination of financial performance $x$ and real outcome $y$ does not play a significant role in the model because I am not estimating the principal's objective function.[12] Any value function that is increasing in real outcome $y$ at a sufficient rate (i.e., "cares sufficiently about $y$") for the principal to prefer implementing the green project will yield the same optimal contract as shown above. I make this assumption for its intuitive appeal and tractability.

Recall that I make two sets of assumptions regarding the agent's actions: first on how they transform the outcome distributions and second on how they fundamentally differ from each other. While the assumption that both actions affect only the means of performances $x$ and $y$ abstracts away from agent's actions having higher moment implications on the joint distribution of financial and real outcomes, it ensures that the model is identified and thus can be estimated from data.

The assumption that financial effort only affects financial outcome $x$ and green project decision has both financial and real implications, might seem as an oversimplification. However, this setting can be mapped into the following in practice: green project selection corresponds to decisions by the manager to improve non-financial outcomes that **can** be optimally implemented with a contract.

For instance, a green project could be installing a costly air purifier in its incinerator, which will reduce carbon emissions but also reduce financial profits. Note that this project will likely not be accepted without a non-financial incentive that rewards non-financial performance.[13] In contrast, financial effort in my model refers to actions that will be taken regardless of incentives

[10] One potential explanation for the positive correlation is that, for the same level of cash flow performance, investors may have preference for favorable real outcomes and therefore reward it with stock returns.

[11] I provide a more detailed discussion of this argument in Appendix E

[12] I can only provide a lower bound of the weight $k$ on non-financial performance by the revealed preference argument. See subsection 5.3 for a discussion.

[13] This is consistent with the view of Homroy et al. (2022) and Ronen (2024). Relatedly, Li et al. (2023) find higher weights on non-financial metrics when efforts to improve non-financial performance are costly.

for real outcomes. This is how my model distinguishes green projects from financial efforts. This distinction, along with the assumption that the green project decision does not incur a personal cost to the manager, allows for disentangling the effects of incentives for real outcomes from those for financial outcomes.

Other main assumptions, including actions being binary, are standard in the literature on structural estimation of compensation contracts.

## 3.2 Contracting Problem

The problem of the principal, who wants to implement both financial effort and project acceptance, is as follows:

$$\max_{w(\cdot)} \mathbb{E}[V(x,y) - w(x,y)|a = (1,1)]. \tag{11}$$

s.t.

$$\mathbb{E}[u(w(x,y),1)|a = (1,1)] \geq \mathbb{E}[u(w(x,y),1)|a = (1,0)] \tag{IC10}$$

$$\mathbb{E}[u(w(x,y),1)|a = (1,1)] \geq \mathbb{E}[u(w(x,y),0)|a = (0,1)] \tag{IC01}$$

$$\mathbb{E}[u(w(x,y),1)|a = (1,1)] \geq \mathbb{E}[u(w(x,y),0)|a = (0,0)] \tag{IC00}$$

$$\mathbb{E}[u(w(x,y),1)|a = (1,1)] \geq u(\underline{w},(0,0)) \tag{P}$$

The first order condition provides the relation among the outcome distributions, one under the optimal action and others under the alternative actions:

$$\mu_{10} C \frac{f_{10}(x,y)}{f_{11}(x,y)} + \mu_{01} \frac{f_{01}(x,y)}{f_{11}(x,y)} = C(\lambda + \mu_{10} + \mu_{01}) - \frac{1}{\rho} e^{\rho w(x,y)} \tag{FOC}$$

Binding incentive compatibility constraints provide:

$$C \int_x \int_y e^{-\rho w(x,y)} f_{11}(x,y) dy dx = C \int_x \int_y e^{-\rho w(x,y)} f_{10}(x,y) dy dx \tag{IC10}$$

$$C \int_x \int_y e^{-\rho w(x,y)} f_{11}(x,y) dy dx = \int_x \int_y e^{-\rho w(x,y)} f_{01}(x,y) dy dx \tag{IC01}$$

Binding participation constraint gives:

$$C \int_x \int_y e^{-\rho w(x,y)} f_{11}(x,y) dy dx = e^{-\rho \underline{w}} \tag{P}$$

Moreover, as $f_{10}(x,y)$ and $f_{01}(x,y)$ are probability distribution functions, they should integrate to $1$ over their supports:

$$\int_x \int_y f_{10}(x,y) dy dx = 1 \tag{12}$$

$$\int_x \int_y f_{01}(x,y) dy dx = 1 \tag{13}$$

## 3.3 Optimal Contract

From the first order condition, the optimal wage is given as follows:

$$w(x,y) = \frac{1}{\rho} \log \left( \rho C(\lambda + \mu_{10} + \mu_{01}) - \rho C \mu_{10} \frac{f_{10}(x,y)}{f_{11}(x,y)} - \rho \mu_{01} \frac{f_{01}(x,y)}{f_{11}(x,y)} \right) \tag{14}$$

A key observation from the equation above is that the more likely an outcome $(x,y)$ is under actions other than the one prescribed by the contract, the lower the wage. This means that the shape of the wage function is informative about the likelihood ratio across different actions, and therefore the shapes of the counterfactual distributions.

Based on the structure of the compensation in the equation above, the highest possible wage $\overline{w}$ is rewarded to $(x,y)$ that perfectly signals $a = (1,1)$:[14]

$$w(x,y) \leq \overline{w} = \frac{1}{\rho} \log \left( \rho C(\lambda + \mu_{10} + \mu_{01}) \right) \tag{15}$$

It can also be seen that, given the base parameters $\rho$ and $C$, the wage function is determined by

[14] I use the term "signal" for expositional convenience but to be precise, the principal will not make any inference in equilibrium as the agent will take the action prescribed in the contract. This comment applies to my discussion below regarding the identifying assumptions.

shadow costs $\lambda$, $\mu_{10}$, and $\mu_{01}$. $\lambda$ can be readily solved for by combining the first order condition with the binding participation constraint and the incentive compatibility constraints:

$$\lambda = \frac{1}{\rho} e^{\rho \underline{w}} \tag{16}$$

Equation (16) is consistent with the intuition that the higher the value of outside options to the agent, the costlier it is to induce the agent to participate in the contract.

On the other hand, it is difficult to obtain analytical expressions for $\mu_{10}$ and $\mu_{01}$ without making additional assumptions regarding the likelihood ratios across actions. Therefore, for the analysis of the optimal contract to follow, I numerically solve for $\mu_{10}$ and $\mu_{01}$ that jointly satisfy the binding participation constraint and the incentive compatibility constraints.

In order to verify the optimality of the contract, I examine the second-order condition. Given that $\rho > 0$, $f_{11}(x, y) > 0$ for all $(x, y)$ within support, and $e^{-\rho w(x,y)} > 0$ for any real $w(x, y)$, the second-order condition can be written as:

$$\rho C(\lambda + \mu_{10} + \mu_{01}) - \rho C \mu_{10} \frac{f_{10}(x, y)}{f_{11}(x, y)} - \rho \mu_{01} \frac{f_{01}(x, y)}{f_{11}(x, y)} > 0 \tag{SOC}$$

For optimal wage $w(x, y)$ from equation (14) violating the (SOC) is equivalent to the wage being complex. Therefore, optimal wage $w(x, y)$ that is real for every $(x, y)$ should satisfy the (SOC).

Figure 3 plots a sample optimal wage. First, it can be seen that the wage increases both in financial performance $x$ and real outcome $y$. This is because higher $(x, y)$ strongly signals both the financial effort and execution of the green project. Second, the wage exhibits a non-linear structure, as implied by equation (14).

## 3.4 Comparative Statics

In this section, I provide comparative statics of the model, to provide a better understanding of how each parameter affects the optimal contract.

Figure 4 shows how the value of outside option $\underline{w}$ affects the optimal compensation. It can be

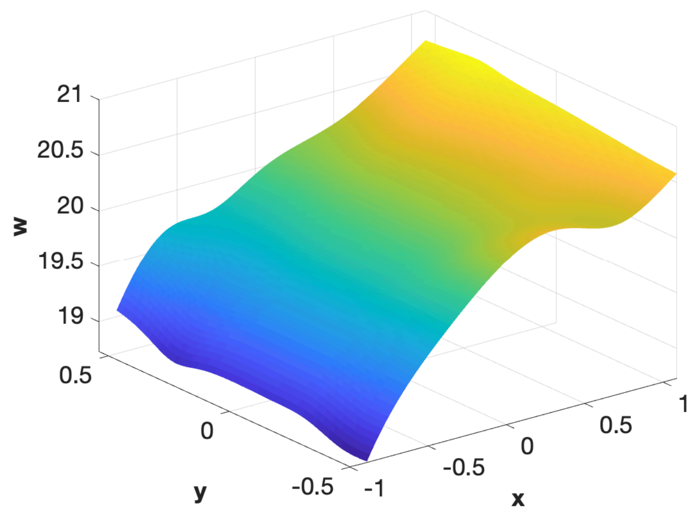
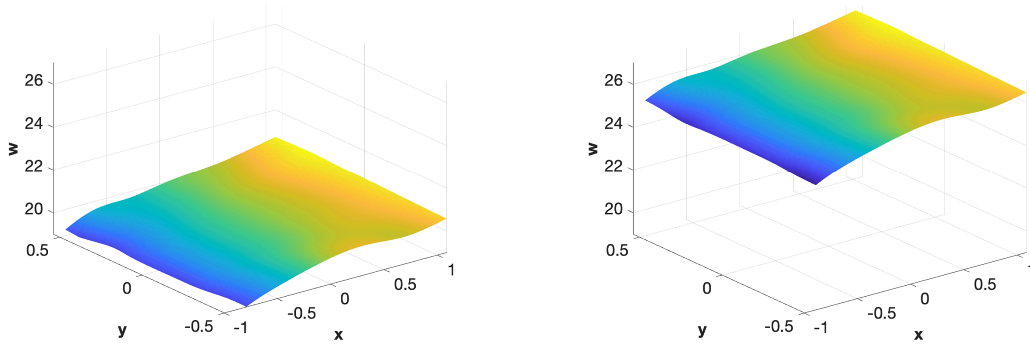



Figure 3: **Optimal compensation** $w(x, y)$ for a sample set of parameters. This figure plots the optimal compensation in equation (14) for given values of parameters $(\rho, \underline{w}, c, \nu_1^x, \nu_2^x, \nu_2^y)$ based on the empirical distribution of the data. $x$, $y$, and $w$ denote financial performance, non-financial performance, and wage, respectively.

seen that the value of the outside option shifts the level of the wage without affecting the shape. In fact, an increase in the value of an outside option results in a dollar-for-dollar increase in the level of wage. This is natural, considering that the outside option affects only the incentive to participate in the contract.

Figure 5 shows how the cost of effort $c$ affects the optimal compensation. It can be seen that an increase in the cost of effect increases both the variance and the level of the wage. For the contract to be incentive compatible with respect to financial effort $a_1$, the sensitivity of the wage with respect to financial performance $x$ increases in the cost of effort, thus increasing the variance of the wage. The risk-averse agent would then require an additional risk premium for this added risk in wage, thereby increasing the level of the wage.

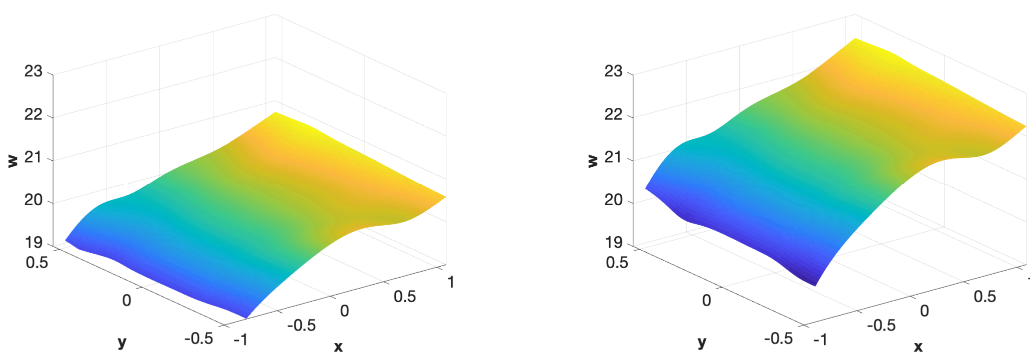
In the remainder of this section, I discuss how the effects of agent's actions, $\nu_1^x$, $\nu_2^x$, and $\nu_2^y$, affect the optimal contract. An important caveat worth noting is that their effects come primarily through the changes in the likelihood ratios, which depend heavily on the shape of the distribution function $f_{11}(x, y)$ and the location of the parameters. Therefore, I focus only on the local effects around the given parameters, for the empirical distribution observed in the data.




(a) Baseline $w(x, y)$

(b) $w(x, y)$ with higher $\underline{w}$

Figure 4: **Optimal compensations** $w(x, y)$ **under baseline parameters (Panel a) and under higher outside option** $\underline{w}$ **(Panel b)** This figure compares the optimal compensation in equation (14) for different values of outside option $\underline{w}$, while keeping other parameters $(\rho, c, \nu_1^x, \nu_2^x, \nu_2^y)$ and the distribution of $(x, y)$ constant. Panel (a) is identical to Figure 3. $x$, $y$, and $w$ denote financial performance, non-financial performance, and wage, respectively.

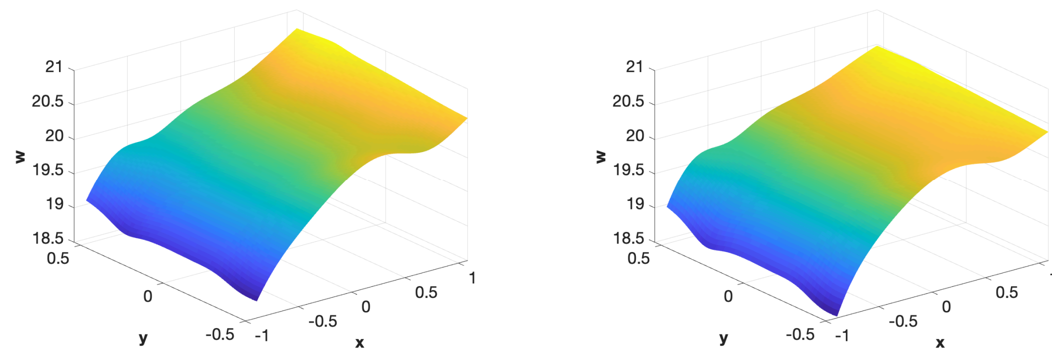



(a) Baseline $w(x, y)$

(b) $w(x, y)$ with higher $c$

Figure 5: **Optimal compensations** $w(x, y)$ **under baseline parameters (Panel a) and under higher cost of effort** $c$ **(Panel b)** This figure compares the optimal compensation in equation (14) for different values of effort cost $c$, while keeping other parameters $(\rho, \underline{w}, \nu_1^x, \nu_2^x, \nu_2^y)$ and the distribution of $(x, y)$ constant. Panel (a) is identical to Figure 3. $x$, $y$, and $w$ denote financial performance, non-financial performance, and wage, respectively.

Figure 6 shows how the effect of financial effort ($\nu_1^x$) affects the optimal compensation. It can be seen that an increase in the effect of financial effort reduces both the variance and the level of the wage. Higher effect of financial effort locally amplifies the difference between $f_{11}(x, y)$ and $f_{01}(x, y)$, and thus the likelihood ratio between the two distributions. In other words, financial performance better signals financial effort, allowing the compensation to be less sensitive with respect to financial performance. As a result, both the variance and the risk premium in wage are lower.

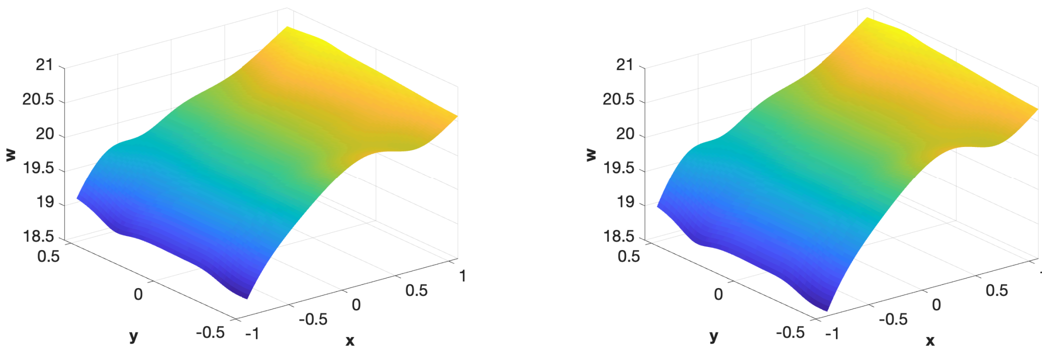



(a) Baseline $w(x, y)$ (b) $w(x, y)$ with higher $\nu_1^x$

Figure 6: **Optimal compensations** $w(x, y)$ **under baseline parameters (Panel a) and under higher effect of effort** $\nu_1^x$ **(Panel b)** This figure compares the optimal compensation in equation (14) for different values of effect of effort $\nu_1^x$, while keeping other parameters $(\rho, \underline{w}, c, \nu_2^x, \nu_2^y)$ and the distribution of $(x, y)$ constant. Panel (a) is identical to Figure 3. $x$, $y$, and $w$ denote financial performance, non-financial performance, and wage, respectively.

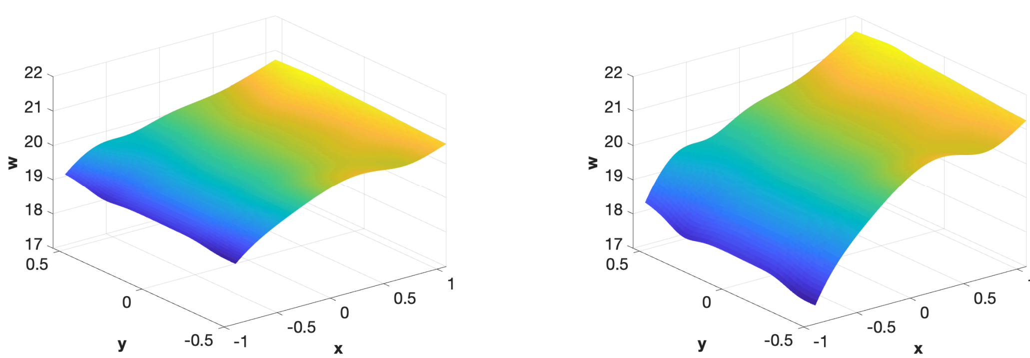
Figure 7 shows how the financial cost of the green project ($|\nu_2^x|$) affects the optimal compensation. It can be seen that an increase in the financial cost of green project increases both the variance and the level of the wage. As the green project entails steeper financial compromise, the agent will require greater rewards to non-financial performances to counteract the disincentive from financial incentives, for the green project to be incentive compatible. As a result, the risk premium should also increase to cover the risk added by the incentive for real outcomes.

Figure 8 shows how the real effect of the green project ($\nu_2^y$) affects the optimal compensation. It can be seen that an increase in the real effect of the green project increases both the variance and the level of the wage.




(a) Baseline $w(x,y)$ (b) $w_{cf}(x,y)$ with higher $|\nu_2^x|$

Figure 7: **Optimal compensations $w(x,y)$ under baseline parameters (Panel a) and under higher financial cost of green project $|\nu_2^x|$ (Panel b)** This figure compares the optimal compensation in equation (14) for different values of financial cost of green project $|\nu_2^x|$, while keeping other parameters $(\rho, \underline{w}, c, \nu_1^x, \nu_2^y)$ and the distribution of $(x,y)$ constant. Panel (a) is identical to Figure 3. $x$, $y$, and $w$ denote financial performance, non-financial performance, and wage, respectively.




(a) Baseline $w(x,y)$ (b) $w_{cf}(x,y)$ with higher $\nu_2^y$

Figure 8: **Optimal compensations $w(x,y)$ under baseline parameters (Panel a) and under higher non-financial effect of green project $\nu_2^y$ (Panel b)** This figure compares the optimal compensation in equation (14) for different values of non-financial effect of green project $\nu_2^y$, while keeping other parameters $(\rho, \underline{w}, c, \nu_1^x, \nu_2^x)$ and the distribution of $(x,y)$ constant. Panel (a) is identical to Figure 3. $x$, $y$, and $w$ denote financial performance, non-financial performance, and wage, respectively.

### 3.5 Identification and Assumptions

For the estimation to be feasible, I make one additional assumption. I assume that extremely favorable outcome in each dimension must be due to action taken in each dimension:

$$\lim_{y\to\infty} \frac{f_{10}(x,y)}{f_{11}(x,y)} = 0 \tag{17}$$

$$\lim_{x\to\infty} \frac{f_{01}(x,y)}{f_{11}(x,y)} = 0 \tag{18}$$

This means that extremely favorable outcome in financial performance $x$ and real outcome $y$ perfectly signals financial effort ($a_1 = 1$) and green project decision ($a_2 = 1$), respectively. The assumption allows me to use wages for extremely favorable outcomes to infer the benchmark when moral hazard in each dimension is not present.[15]

From the first order condition (FOC), binding constraints, and the assumptions above, I obtain the following five moment conditions. For a given level of risk aversion $\rho = \hat{\rho}$, I estimate the parameters $(C, \underline{w}, \lambda, \mu_{10}, \mu_{01})$ from these five moment conditions.

$$\begin{bmatrix} \frac{1}{C}e^{-\hat{\rho}\underline{w}} \\ \hat{\rho}(\lambda C + \mu_{01}(C-1)) \\ \frac{1}{\hat{\rho}\lambda C} \\ \hat{\rho}(\lambda + \mu_{10} + \mu_{01})C \\ \hat{\rho}((\lambda + \mu_{10} + \mu_{01})C - \mu_{01}) \end{bmatrix} = \begin{bmatrix} \alpha \\ \beta \\ \alpha \\ \gamma \\ \delta \end{bmatrix}, \tag{19}$$

[15] This is an important identifying assumption in Gayle and Miller (2015) as well.

where data moments $(\alpha, \beta, \gamma, \delta)$ are defined as follows:

$$\alpha = \mathbb{E}[e^{-\hat{\rho} w(x,y)}] \tag{20}$$

$$\beta = \mathbb{E}[e^{\hat{\rho} w(x,y)}] \tag{21}$$

$$\gamma = e^{\hat{\rho} \overline{w}} \tag{22}$$

$$\delta = \lim_{y \to \infty} \mathbb{E}[e^{\rho w(x,y)} | y] \tag{23}$$

The first moment $\alpha$ is the agent's expected utility (reversed sign) given wage $w(x, y)$ and outcome distribution $f_{11}(x, y)$. The second moment $\beta$ captures the expected level of the wage (adjusted for risk aversion) to the agent. The third moment $\gamma$ effectively represents the theoretical upper bound of the wage. $\overline{w}$ denotes the highest wage in the estimated wage function. The fourth moment $\delta$ captures the expected level of wage under extremely high non-financial performance.

By inverting the moment conditions above, I obtain the following analytical expressions for the parameters:

$$\begin{bmatrix} \underline{w} \\ c \\ \lambda \\ \mu_{10} \\ \mu_{01} \end{bmatrix} = \begin{bmatrix} -\frac{1}{\hat{\rho}} \log\left(\frac{\alpha\beta - 1 + \alpha(\gamma - \delta)}{\gamma - \delta}\right) \\ \frac{1}{\hat{\rho}} \log\left(\frac{\alpha\beta - 1 + \alpha(\gamma - \delta)}{\alpha(\gamma - \delta)}\right) \\ \frac{1}{\hat{\rho}} \frac{(\gamma - \delta)}{\alpha\beta - 1 + \alpha(\gamma - \delta)} \\ \frac{1}{\hat{\rho}} \frac{\alpha(\gamma - \delta)(\delta - \beta)}{\alpha\beta - 1 + \alpha(\gamma - \delta)} \\ \frac{\gamma - \delta}{\hat{\rho}} \end{bmatrix} \tag{24}$$

Then, I estimate the shift parameters $(\nu_1^x, \nu_2^x, \nu_2^y)$ with the following moment conditions derived from the incentive compatibility condition with respect to financial effort (IC01) and the first order condition (FOC):

$$\begin{bmatrix} \frac{1}{C}\int_x\int_y e^{-\hat{\rho}w(x,y)} f_{11}(x+\nu_1^x, y)dydx \\ \hat{\rho}\mu_{10}C\nu_2^x + \hat{\rho}\mu_{01}\nu_1^x \\ \hat{\rho}\mu_{10}C\nu_2^y \end{bmatrix} = \begin{bmatrix} \alpha \\ \eta_x - \hat{\rho}(C\lambda + (C-1)\mu_{01})m_x \\ \eta_y - \hat{\rho}(C\lambda + (C-1)\mu_{01})m_y \end{bmatrix}, \tag{25}$$

where data moments $(\eta_x, \eta_y, m_x, m_y)$ are defined as follows:

$$\eta_x = \int_x\int_y xe^{\hat{\rho}w(x,y)} f_{11}(x,y)dydx \tag{26}$$

$$\eta_y = \int_x\int_y ye^{\hat{\rho}w(x,y)} f_{11}(x,y)dydx \tag{27}$$

$$m_x = \int_x\int_y xf_{11}(x,y)dydx \tag{28}$$

$$m_y = \int_x\int_y yf_{11}(x,y)dydx \tag{29}$$

Moments $\eta_x$ and $\eta_y$ capture how the level of wage varies with the performances $x$ and $y$, respectively. Moments $m_x$ and $m_y$ are means of performances $x$ and $y$, respectively.

By substituting the above expression for $C$ into the first moment condition of equation (25), I get the following condition for $\nu_1^x$:

$$\int_x\int_y e^{-\hat{\rho}w(x,y)} f_{11}(x+\nu_1^x, y)dydx = \frac{\alpha\beta - 1 + \alpha(\gamma-\delta)}{\gamma-\delta} \tag{30}$$

While $\nu_1^x$ cannot be analytically solved for without distributional assumptions, it can still be numerically estimated.

With $\nu_1^x$ pinned down, I solve for $\nu_2^x$ and $\nu_2^y$ from the second and third moment conditions of equation (25):

$$\nu_2^x = \frac{1}{\hat{\rho}\mu_{10}C}\left(\eta_x - \hat{\rho}(C\lambda + (C-1)\mu_{01})m_x - \hat{\rho}\mu_{01}\nu_1^x\right) \tag{31}$$

$$\nu_2^y = \frac{1}{\hat{\rho}\mu_{10}C}\left(\eta_y - \hat{\rho}(C\lambda + (C-1)\mu_{01})m_y\right) \tag{32}$$

## 3.6 Intuition for Identification

In this section, I provide intuition for how the features of the observed wage function map into the underlying parameters of the model.

I begin with the parameters that relate to the participation constraint, the value of outside option $\underline{w}$ and the shadow cost of participation $\lambda$. Recall from equation (14) that the participation constraint affects the wage function only through the level, not the shape. It is therefore clear that the role of $\lambda$ is merely matching the level of the observed wage that is not explained by other parameters which simultaneously affect both the level and the variation of the wage. From equation (16), it is clear that $\underline{w}$ and $\lambda$ are effectively interchangeable, given the risk aversion parameter $\rho$.

Identification for the shadow costs of incentive compatibility conditions, $\mu_{01}$ for the financial effort and $\mu_{10}$ for the green project, comes from the differences in the level of wages under normal vs extremely favorable outcomes that almost perfectly signal agent's actions. When both financial performance $x$ and real outcome $y$ are extremely favorable ($x \to \infty$ and $y \to \infty$), it is clear that the agent took both financial effort ($a_1 = 1$) and green project ($a_2 = 1$), following from the assumptions in equations (17) and (18). Then, maximum wage $\gamma$ paid to the agent, would reflect neither $\mu_{01}$ nor $\mu_{10}$. When non-financial performance is extremely favorable ($y \to \infty$), the outcome only signals that $a_2 = 1$, but not necessarily that $a_1 = 1$. Here, expected wage under extremely favorable non-financial performance $\delta$ would reflect only $\mu_{01}$. Therefore, the difference between $\gamma$ and $\delta$ provides $\mu_{01}$. Across all outcomes, expected level of wage $\beta$ should reflect both shadow costs, $\mu_{01}$ and $\mu_{10}$. Thus, the difference between $\delta$ and $\beta$ provides $\mu_{10}$. Figure 9 summarizes this intuition and Figure 10 visualizes the wage moments $(\beta, \gamma, \delta)$.

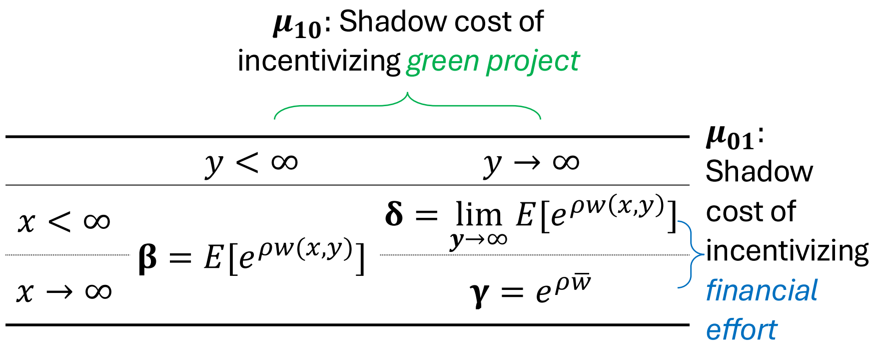



Figure 9: **Intuition for Identifying Shadow Costs of Incentive Compatibility Conditions** This figure summarizes the intuition for how the shadow costs of incentive compatibility conditions $(\mu_{10}, \mu_{01})$ can be identified from wage moments $(\beta, \gamma, \delta)$. The rows and columns indicate which region of financial performance $x$ and green performance $y$, respectively, the wage moments belong to. Figure 10 visualizes these wage moments.

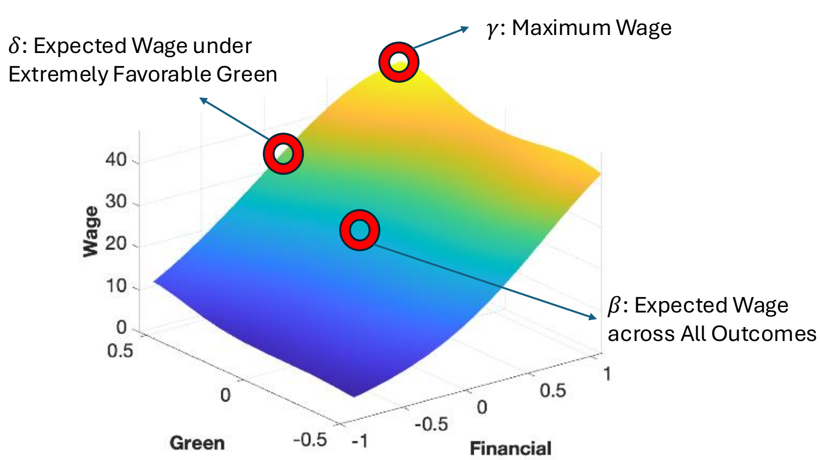



Figure 10: **Illustration of Wage Moments** This figure provides an intuitive illustration for the wage moments $(\beta, \gamma, \delta)$. $\gamma$ is at the maximum level where both financial and green performances are extremely favorable. $\delta$ is on the edge of the wage function where the green performance is extremely favorable. $\beta$ is in the center, to emphasize that it is an expectation over all outcomes. A point to note is that these moments are levels of wage *adjusted for risk aversion*. Precise definitions of these moments are given in equations (21) to (23).

The cost of effort $c$ is related to the wage variance. Product between moments $\alpha$, which is the the (negative) expected utility of the agent and $\beta$, which is the exponential transformation of the wage that captures the level, provides insight into identifying $C = e^{\rho c}$:

$$\alpha\beta = \mathbb{E}[e^{-\rho w(x,y)}] \cdot \mathbb{E}[e^{\rho w(x,y)}] = 1 + \frac{\mu_{01}}{\lambda}\left(1 - \frac{1}{C}\right) \tag{33}$$

While it is difficult to analyze a product of expectations for an arbitrary distribution, restricting to normal distributions for outcomes and linear compensation schemes provides the following equality:

$$e^{\rho Var(w(x,y))} = 1 + \frac{\mu_{01}}{\lambda}\left(1 - \frac{1}{C}\right) \tag{34}$$

The lefthand side captures the disutility of wage risk to the agent, while the righthand side increases in the cost of effort. This suggests that volatile wage is consistent with high cost of effort. The intuition is that the agent requires high-powered incentives when the cost of effort is high. For the same effect of financial effort $\nu_1^x$, the agent should get higher rewards for favorable outcomes when the cost of effort is higher, for the contract to be incentive compatible. This in turn increases the incentive power for real outcomes, as the agent should be compensated for the loss of financial performance caused by the green project. In summary, increase in the cost of effort leads to increase in the incentive power for both financial and non-financial outcomes, resulting in a more volatile compensation structure overall.

Effect of financial effort $\nu_1^x$ is identified from the incentive compatibility condition on financial effort. When the constraint binds, the expected utility of the agent should be equal between exerting financial effort and shirking, as shown in equation (IC01). Rewriting the equation through change of variables gives:

$$C = \frac{\mathbb{E}\big[e^{\rho w(x-\nu_1^x,y)}\big]}{\mathbb{E}\big[e^{\rho w(x,y)}\big]} \tag{35}$$

The intuition here is simply that an increase in the expected utility from wage should match the disutility of exerting costly effort. It can be seen here that the sensitivity of the wage to financial outcome and $\nu_1^x$ are substitutes, in terms of how they affect the expected utility under shirking relative to that under exerting financial effort. Therefore, low sensitivity of wage to financial effort is consistent with high $\nu_1^x$.

Financial and real effects of the green project, $\nu_2^x$ and $\nu_2^y$, come from the covariance between the level of the wage and performance in each dimension. Rewriting equations (31) and (32) gives:

$$Cov(e^{\rho w(x,y)}, x) = (\gamma - \delta)\nu_1^x + (\delta - \beta)\nu_2^x \tag{36}$$

$$Cov(e^{\rho w(x,y)}, y) = (\delta - \beta)\nu_2^y \tag{37}$$

Recall that $\gamma - \delta$ and $\delta - \beta$ capture shadow costs of incentivizing financial effort and the green project, respectively. It can be seen that the covariance between the level of the wage and each performance outcome is a linear combination of effects of effort, weighted by respective shadow costs.

# 4 Data

## 4.1 Data Sources

I merge various datasets to construct a firm-year panel of compensation, financial performance, and environmental performance covering over 600 firms in the U.S. from 2012 to 2022, the longest overlapping time period. The five main sources of data are as follows.

**Measurement of Compensation** To measure the change of CEO's wealth due to compensation, I follow the standardized approach introduced in Bertomeu et al. (2023a). First, I begin with all cash and non-equity compensation from Execucomp, including salary, bonus, and long-term incentives. Second, I add the change in wealth due to stock compensation, both restricted and owned. To this end, I use the stock holdings from Execucomp, as well as the return information from CRSP-Compustat. Third, I add the change in wealth due to option compensation. I use the option holdings from Execucomp, and inputs of the Black-Scholes formula from CRSP.

**Compensation Metrics Data** To obtain firm compensation metric data, I use Executive Compensation Analytics (ECA) aggregated by the Institutional Shareholder Services (ISS). This data set is annual, from 2009 to 2022, and it comes from firms' disclosures of executive compensation.

**Carbon Emission Data** For data on firms' greenhouse gas (GHG) emissions, I use Trucost aggregated by the S&P Global. To construct the measure of firms' non-financial performance, I use the scope 1 and 2 emission intensity, following the literature.[16] This data set is annual. For the performance measure, I use the negative log change in emission intensity, to capture the reduction in emissions.

**Stock Return Data** I obtain stock return information from CRSP. As a measure of financial performance, I construct the abnormal return as the return over the firm-year less the concurrent market return, following Gayle and Miller (2015).

**Firm Financial Data** I obtain accounting and financial information from the Compustat.

## 4.2 Sample Characterization

To take my model to the data, I focus on firms that implement green incentives. An ideal dataset would include a mandatory filing of all metrics used for CEO compensation. However, there is no such reporting requirement and the metrics are disclosed voluntarily by firms' discretion. Therefore, this means that restricting the sample only to firms that explicitly pay on environmental outcomes would likely miss firms that quietly pay on those metrics. Another challenge is that even if one has such an ideal dataset, it is not straightforward to determine whether a given metric is green or not. Prominent examples include metrics related to worksite safety for employees, such as hazardous chemicals, which would harm not only the employees but also the environment. To address these challenges, I use the sample of firms that explicitly implement non-financial metrics, as identified by the ECA.

[16] e.g., Bolton and Kacperczyk (2021), and Jung et al. (2021) among others. In particular, Aswani et al. (2023) argue that intensity is the appropriate measure for green performance when it comes to individual firms.

This raises two key questions. First, is the compensation significantly sensitive to green performance for firms that disclose incentives for real outcomes? This is important in validating whether the disclosure of non-financial incentive is a reasonable proxy of paying on green performance. Second, do "S or G" firms (i.e., firms with metrics that ECA identifies as non-environmental) also have compensation sensitive to green performance? If the answer is yes, it supports the conjecture that there are firms that quietly pay on green performance without disclosing.

To test the two questions above, I regress compensation on green performance and financial performance using three samples. The results are tabulated in Table 1. Column (1) presents the result for all the firms available in my dataset, regardless of whether they implement incentives for real outcomes. In this sample, I find that the compensation is *not* significantly sensitive to green performance. The magnitude of the coefficient is also small. These suggest that firms that do not disclose any non-financial metric are likely not paying on green performance. In contrast, column (2) presents the result only for firms that explicitly implement incentives for real outcomes. In this sample, the compensation is significantly sensitive to green performance. These results collectively suggest that the disclosure of non-financial metrics (column (2) sample) is a reasonable proxy of paying on green performance.

Next, to test the second question, I focus on firms that explicitly pay on metrics other than green (environmental) in column (3) of Table 1. For this sample, I find that the compensation is still significantly sensitive to green performance. This is consistent with firms that pay explicitly on other non-financial metrics quietly paying on green performance. As an alternative approach, one may focus on E firms only. In this case, as expected, the coefficient on green performance is the highest as presented in column (4); however, due to the smaller sample size, the statistical significance falls due to lower power. Therefore, overall, the sample of firms explicitly paying on non-financial metrics is a reasonable approximation of the sample of firms with green incentives.[17]

[17] Moreover, to the extent that non-financial performances are correlated through firms' actions and not errors, my inferences are not affected.

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | All Firms | E,S,G Firms | S,G Firms | E Firms |
| Emiss Int Reduction | 0.980 | 19.97*** | 21.99*** | 26.94* |
| | (0.07) | (3.13) | (2.99) | (1.93) |
| Abnormal Return | 176.1*** | 54.85*** | 53.68*** | 51.66*** |
| | (6.52) | (18.13) | (17.70) | (4.39) |
| Year FE | Y | Y | Y | Y |
| N | 7296 | 1419 | 1275 | 141 |
| Adj-R2 | 0.0228 | 0.252 | 0.260 | 0.190 |

*t* statistics in parentheses

* $p < .10$, ** $p < .05$, *** $p < .01$

Table 1: **Wage Sensitivity to Green Performance across Samples** This table reports the results from regressing Total Pay on Emission Intensity Reduction (green performance) and Abnormal return (financial performance). t-statistics are computed with robust standard errors. Variables used in this regression are as follows: Total Pay (wage in $ million), Abnormal Return (defined as return less contemporaneous market return), and Emission Intensity Reduction (defined as negative log change in emission intensity).

Table 2 displays the summary statistics of key variables.[18] I make use of the following three variables in the estimation: wage, abnormal return as a measure of financial performance, and emission reduction as a measure of non-financial performance. I construct the abnormal return variable by subtracting the contemporaneous market return. To construct emission reduction, I compute the *negative* of the log change in scope 1 and 2 emission intensity. I take the negative so that the positive value of the variable can be interpreted as an improvement in terms of environmental performance. As for the remaining variables, I find that the descriptive statistics are consistent with other related works, such as Cohen et al. (2023) and Bertomeu et al. (2023a).

To verify the identification assumptions, I examine the correlations among wage, abnormal return, and emission reduction. Table 3 shows that although the pair-wise correlations are low, they are positive. Following from the discussion in Subsection 3.1 (elaborated in Appendix E), these positive correlations suggest that the incentive compatibility for green project (IC10) is indeed binding and that green project entails a negative financial impact ($\nu_2^x < 0$).

[18] I truncate the top and bottom 5% of the sample to mitigate the impact of outliers.

| | Mean | St.Dev. | 25th percentile | 75th percentile | Count |
|---|---|---|---|---|---|
| **Total Pay** | 22.15 | 31.82 | 3.30 | 28.40 | 1419 |
| **Abnormal Return** | 0.00 | 0.29 | -0.21 | 0.19 | 1419 |
| **Emission Reduction** | 0.03 | 0.12 | -0.03 | 0.07 | 1419 |
| Log Size | 8.81 | 1.60 | 7.66 | 10.01 | 1419 |
| ROA | 0.04 | 0.11 | 0.01 | 0.08 | 1419 |
| Log Emission | 12.30 | 2.68 | 10.45 | 14.19 | 1419 |
| Observations | 1419 | | | | |

Table 2: **Summary Statistics** This table reports the summary statistics of the main sample. The first three variables, Total Pay (wage in $ million), Abnormal Return (defined as return less contemporaneous market return), and Emission Reduction (defined as negative log change in emission intensity) are used in the estimation.

| | Total Pay | Abnormal Return | Emission Reduction |
|---|---|---|---|
| Total Pay | 1.00 | | |
| Abnormal Return | 0.49 | 1.00 | |
| Emission Reduction | 0.11 | 0.08 | 1.00 |

Table 3: **Correlations among Main Variables** This table reports pairwise correlations among the three main variables: Total Pay (wage in $ million), Abnormal Return (defined as return less contemporaneous market return), and Emission Reduction (defined as negative log change in emission intensity), which are used in the estimation.

# 5 Estimation and Results

## 5.1 Non-parametric Estimation of Density and Wage Functions

The first step of the estimation is estimating $f_{11}(x, y)$, the joint density of $(x, y)$ conditional on action $a = (1, 1)$ stipulated in the contract, and $w(x, y)$, the wage function. For the joint density, I use a bivariate kernel density estimator with a standard normal kernel and bandwidths $(h_x, h_y)$:

$$\hat{f}_{11}(x, y) = \frac{1}{N h_x h_y} \sum_{i=1}^{N} \phi\left(\frac{x - X_i}{h_x}\right) \phi\left(\frac{y - Y_i}{h_y}\right) \tag{38}$$

Where bandwidths $(h_x, h_y)$ with smoothing factor $f_f$ are given as:

$$h_x = f_f \cdot \hat{\sigma}_x \cdot N^{\frac{1}{6}} \tag{39}$$

$$h_y = f_f \cdot \hat{\sigma}_y \cdot N^{\frac{1}{6}} \tag{40}$$

For the wage function, I use a bivariate Nadaraya-Watson Estimator with a standard normal kernel and bandwidths $(h'_x, h'_y)$ :

$$\hat{w}(x, y) = \frac{\sum_{i=1}^{N} \phi\left(\frac{x - X_i}{h'_x}\right) \phi\left(\frac{y - Y_i}{h'_y}\right) W_i}{\sum_{i=1}^{N} \phi\left(\frac{x - X_i}{h'_x}\right) \phi\left(\frac{y - Y_i}{h'_y}\right)} \tag{41}$$

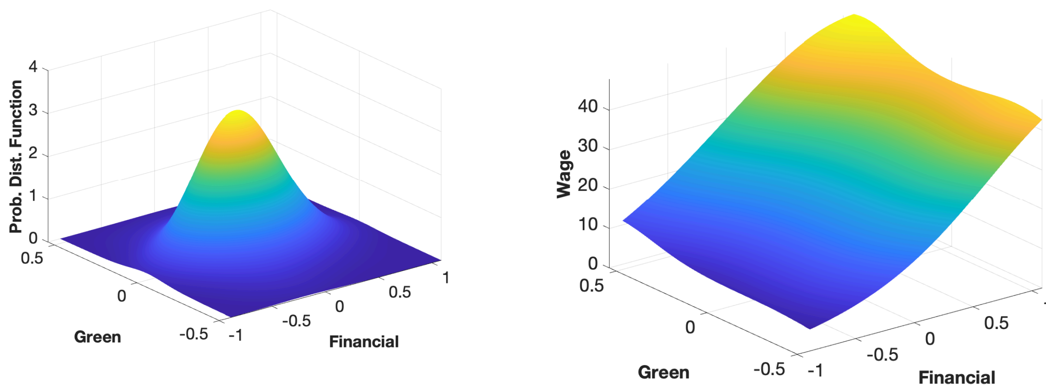
Where bandwidths $(h'_x, h'_y)$ with smoothing factor $f_w$ are given as:

$$h'_x = f_w \cdot \hat{\sigma}_x \cdot N^{\frac{1}{6}} \tag{42}$$

$$h'_y = f_w \cdot \hat{\sigma}_y \cdot N^{\frac{1}{6}} \tag{43}$$

I use a smoothed bandwidth for estimations of the wage function and the distribution function, as the rule-of-thumb bandwidth tends to over-fit the data.

Figure 11 presents the nonparametrically estimated joint density function $\hat{f}_{11}(x, y)$ and wage function $\hat{w}(x, y)$. As discussed in subsection 4.2, the wage function is increasing both in the financial performance $x$ and non-financial signal $y$. This, in conjunction with $x$ and $y$ being positively correlated, suggests that incentive compatibility with respect to green project binds and that green project entails a negative financial impact ($\nu_2^x < 0$).




(a) $\hat{f}_{11}(x, y)$ (b) $\hat{w}(x, y)$

Figure 11: **Nonparametric estimation of density $\hat{f}_{11}(x, y)$ (Panel a) and wage $\hat{w}(x, y)$ (Panel b)** This figure plots the non-parametrically estimated functions, joint density $\hat{f}_{11}(x, y)$ and wage $\hat{w}(x, y)$, where $x$ and $y$ denote financial performance and green performance, respectively. I use bivariate Nadaraya-Watson estimators with standard normal kernels for the two functions.

## 5.2 Parameter Estimation

The second step is to estimate the parameters $(C, \underline{w}, \nu_1^x, \nu_2^x, \nu_2^y, \lambda, \mu_{10}, \mu_{01})$ from the estimated joint density $\hat{f}_{11}(x, y)$ and wage function $\hat{w}(x, y)$. For a given level of risk aversion $\rho$, I compute the moments $(\alpha, \beta, \gamma, \delta)$ in equations (20) to (23), as well as moments $(\eta_x, \eta_y, m_x, m_y)$ from equations (26) to (29). From the inverted moment conditions in equation (24), I obtain the estimates for $(c, \underline{w}, \lambda, \mu_{10}, \mu_{01})$, from moments $(\alpha, \beta, \gamma, \delta)$. As there is no analytical expression for $\nu_1^x$, I numerically estimate the parameter from the condition in equation (30). Specifically, I search for the value of $\nu_1^x$ that satisfies the equality within a specified range.[19] With $\nu_1^x$ pinned down, I estimate the remaining parameters, $\nu_2^x$ and $\nu_2^y$, from equations (31) and (32), as well as moments $(\eta_x, \eta_y, m_x, m_y)$.

[19] I confirm that the LHS of equation (30) varies monotonically w.r.t. parameter $\nu_1^x$ within the search range, which is $[0, 0.1]$.

## 5.3 Main Results on the Implications of Green Incentives

Table 4 tabulates the parameter estimates for the sample with incentives for real outcomes and the entire sample, respectively. For the benchmark risk aversion of $\rho = 0.08$[20], the value of outside option $\underline{w}$ and cost of effort $c$ are estimated at \$19.04 million and \$808,510, respectively. I find that financial effort substantially improves financial performance by $5.2\%$ of stock return. The magnitude is consistent with estimates from prior literature, including Gayle and Miller (2015).

| | Parameter | Estimate |
|---|---|---|
| $\underline{w}$ | : Value of outside option (\$ mil.) | 19.0 |
| c | : Effort cost (\$ mil.) | 0.809 |
| $\nu_1^x$ | : Financial effect of financial effort $a_1$ | 0.052 |
| $\nu_2^x$ | : Financial effect of green project $a_2$ | $-0.0131$ |
| $\nu_2^y$ | : Green effect of green project $a_2$ | 0.0176 |

Table 4: **Estimated Parameters** This table tabulates the estimates for parameters $(\underline{w}, c, \nu_1^x, \nu_2^x, \nu_2^y)$ for risk aversion of $\rho = 0.08$. Confidence intervals for these parameters are provided in Table 5.

As for the green project incentivized by green incentives, I find that it entails a trade-off between $1.3\%$ loss of stock return and $1.8\%$ improvement in carbon emission intensity reduction per year.[21] Based on these estimates, I infer that firms with non-financial metrics in their executive compensation are willing to compromise substantial financial value, around $25\%$ of the value created by CEO's financial effort, to improve non-financial performances. The estimates further suggest that green incentives play an important role in improving green performance: approximately 60% of the reduction in carbon emission intensity is explained by green incentives.

A caveat in interpreting the estimates is that they are derived from the contract design, which reflects the principal's expectation, rather than the realized outcomes. However, this does not affect the interpretation that the principal is *willing to accept* the estimated trade-off between financial and green outcomes induced by green incentives.

[20] Brenner (2015) estimates the median relative risk aversion of 1 for CEOs. Based on the median compensation of \$12 million, I adjust the absolute risk aversion parameter at $1/12 \approx 0.08$.

[21] The willingness to forgo $1.3\%$ of return is much higher than the estimates in the green bond literature (see Baker et al. (2022) for a comprehensive discussion) but within the range of estimates for green stocks (e.g., Pastor et al. (2022)).

In terms of the principal's objective function, the result provides a lower bound on the value that the principal places on improvement in non-financial performance. Specifically, the principal values $1\%$ reduction in carbon emission intensity at approximately $0.74\%$ of firm value.[22] Given that the firm value (stock price) is priced by stock market investors, this estimate represents the differential between the principal's valuation and the market's valuation of the green project. In other words, the board (principal) values environmental performance more than the marginal investor in the stock market.[23]

Identifying a specific mechanism behind this result requires a comprehensive model of both the capital market and the contracting problem, and therefore is beyond the scope of this paper. Yet, I discuss three potential mechanisms— misalignment between the board and the shareholders, shareholder activism, and information asymmetry between the board and the market— for the discrepancy between the principal and the marginal investor in the stock market in Appendix D. Moreover, I conduct a cross-sectional analysis to explore how the trade-offs associated with green incentives vary with respect to the quality of corporate governance. I find that the financial gain forgone for emission reductions is high across the board, while firms with stronger governance achieve substantially greater reduction in emissions (Table D.1).

## 5.4 Confidence Intervals

Following the standard approach to construct confidence intervals for structural parameters, I construct confidence intervals around the parameter estimates based on bootstrap simulations with $N = 1000$. Figure 12 plots the distribution of parameters, as well as the cost of moral hazard, from the bootstrap simulations. I find that simulation estimates are generally distributed around the point estimates from the main estimation. Table 5 tabulates the confidence intervals at the $90\%$ and the $95\%$ levels, showing that all parameters are statistically significant at the $90\%$ level.

[22] This is the lower bound for the weight $k$ in the principal's objective function $V(x, y)$ introduced in equation (1). By the revealed preference argument, the principal should value green performance at least as much as the financial value forgone for green performance.

[23] Relatedly, Hazarika et al. (2025) find that firms adopting ESG pay suffered a reduction in Tobin's Q due to backlash against ESG objectives. However, given that my sample period predates their shock, the backlash does not fully explain my results.

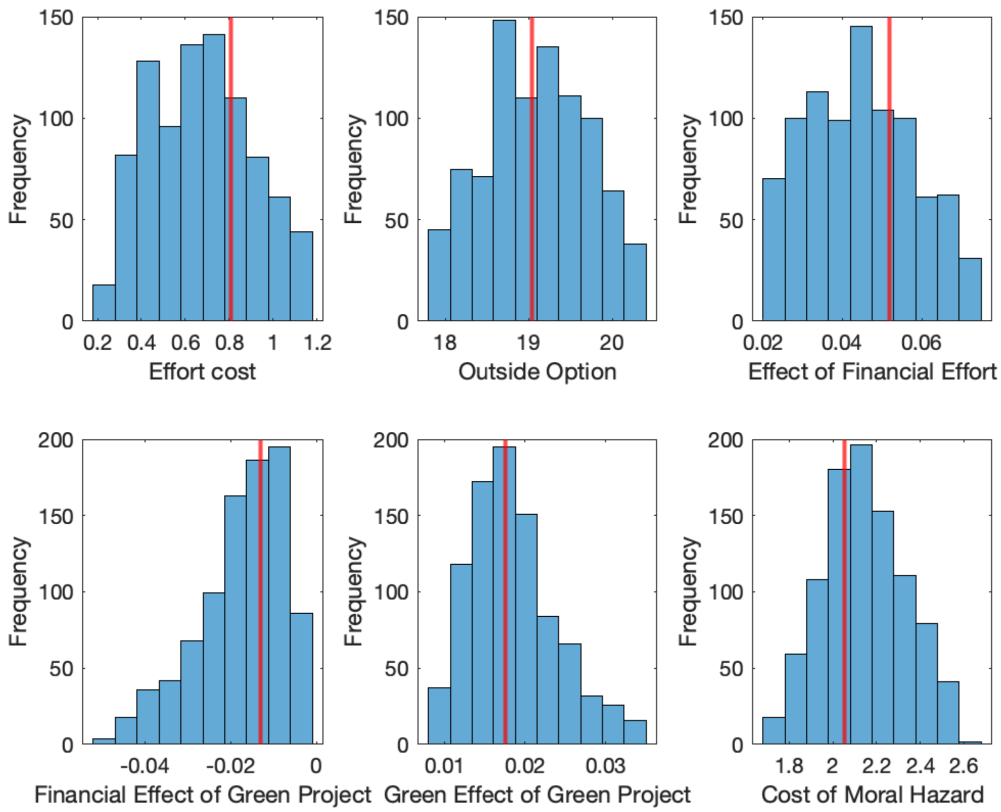



Figure 12: **Bootstrap Results** This figure plots the histogram of estimates for parameters $(c, \underline{w}, \nu_1^x, \nu_2^x, \nu_2^y)$, as well moral hazard cost $\Delta V$ defined in section 6 from the bootstrap simulations. The red vertical line indicates the point estimate for each parameter from the main estimation tabulated in Table 4.

| | Parameter | 90% CI | 95% CI |
|---|---|---|---|
| $\underline{w}$ | : Value of outside option ($ mil.) | $(17.8, 20.4)$ | $(17.6, 20.8)$ |
| $c$ | : Effort cost ($ mil.) | $(0.261, 1.18)$ | $(0.207, 1.33)$ |
| $\nu_1^x$ | : Financial effect of financial effort $a_1$ | $(0.02, 0.076)$ | $(0.016, 0.085)$ |
| $\nu_2^x$ | : Financial effect of green project $a_2$ | $(-0.049, -0.002)$ | $(-0.060, 0.001)$ |
| $\nu_2^y$ | : Green effect of green project $a_2$ | $(0.010, 0.035)$ | $(0.009, 0.040)$ |

Table 5: **Estimated 90% and 95% Confidence Intervals for Parameters** This table reports the confidence intervals for parameters $(\underline{w}, c, \nu_1^x, \nu_2^x, \nu_2^y)$ at 90% (left column) and 95% (right column) levels. The point estimates are provided in Table 4.

# 6 Counterfactual Analysis: Decomposing Moral Hazard

## 6.1 Approach

In this section, I analyze the moral hazard problem in contracts with financial and incentives for real outcomes and decompose the moral hazard for each incentive. I define the cost of moral hazard $\Delta V$ as the expected wage the principal should offer the agent in excess of her first-best wage $w_{FB}$, which is the sum of the effort cost and the value of the outside option:

$$\Delta V = \mathbb{E}[w(x, y)|a = (1, 1)] - \underbrace{(c + \underline{w})}_{w_{FB}} \tag{44}$$

To answer the question of how costly it is to incentivize a manager to execute a green project on top of exerting financial effort, I decompose the cost of moral hazard separately for action induced by each incentive. I define the cost of green moral hazard as the cost incurred to the principal because the principal cannot observe the agent's green project decision. Let $w_{cf}(x, y)$ denote the counterfactual wage that optimally implements both financial and green project when green project decision is observable but financial effort is not. The cost of green moral hazard $\Delta V_G$ is therefore given as:

$$\Delta V_G = \mathbb{E}[w(x, y) - w_{cf}(x, y)|a = (1, 1)] \tag{45}$$

Then, the cost of financial moral hazard $\Delta V_F$ is naturally given as the remaining portion of the cost of moral hazard:

$$\Delta V_F = \Delta V - \Delta V_G = \mathbb{E}[w_{cf}(x, y)|a = (1, 1)] - \underbrace{(c + \underline{w})}_{w_{FB}} \tag{46}$$

In order to compute the cost of green moral hazard, I solve for the counterfactual contract that implements both financial effort and green project when green project decision is observable but financial effort is not. This counterfactual contract should solve:

$$\max_{w(\cdot)} \mathbb{E}[V(x,y) - w(x,y)|a = (1,1)]. \tag{47}$$

s.t.

$$\mathbb{E}[u(w(x,y),1)|a = (1,1)] \geq \mathbb{E}[u(w(x,y),0)|a = (0,1)] \tag{IC}$$

$$\mathbb{E}[u(w(x,y),1)|a = (1,1)] \geq u(\underline{w},(0,0)) \tag{P}$$

The first order condition then gives:

$$\begin{aligned} 1 = {} & \lambda_{cf}\rho C e^{-\rho w_{cf}(x,y)} \\ & + \mu_{cf}\rho \left( C e^{-\rho w_{cf}(x,y)} - e^{-\rho w_{cf}(x,y)} \frac{f_{01}(x,y)}{f_{11}(x,y)} \right) \end{aligned} \tag{FOC'}$$

The above can be rearranged to yield the counterfactual wage function $w_{cf}(x,y)$:

$$w_{cf}(x,y) = \frac{1}{\rho} \log \left( \rho \left( C(\lambda_{cf} + \mu_{cf}) - \mu_{cf} \frac{f_{01}(x,y)}{f_{11}(x,y)} \right) \right) \tag{48}$$

The shadow costs $\lambda_{cf}$ and $\mu_{cf}$ have yet to be determined. As shown in equation (16) in the main model, $\lambda$ can be solved for by combining the (FOC') with the binding participation and incentive compatibility constraints:

$$\lambda_{cf} = \frac{1}{\rho} e^{\rho \underline{w}} \tag{49}$$

Solving for $w_{cf}(x,y)$ is then reduced to finding $\mu_{cf}$ that satisfies both the binding incentive compatibility constraint and the binding participation constraint:

$$\int_x \int_y e^{-\rho w_{cf}(x,y)} f_{11}(x,y)dydx = \int_x \int_y e^{-\rho w_{cf}(x,y)} f_{10}(x,y)dydx \tag{IC'}$$

$$C \int_x \int_y e^{-\rho w_{cf}(x,y)} f_{11}(x,y)dydx = e^{-\rho \underline{w}} \tag{P'}$$

## 6.2 Main Results on Green Moral Hazard

Table 6 shows the estimates for the costs of moral hazard. Out of the total cost of moral hazard of $2.05 million, I find that the green moral hazard explains around 84%, of $1.72 million. That the cost of green moral hazard is greater than that of financial moral hazard suggests that the information asymmetry is more severe regarding the CEO's green project decision than that regarding the CEO's financial effort. Figure 13 summarizes this result.

| | Cost of Moral Hazard | Estimate |
|---|---|---|
| $\Delta V$ | : Total cost of moral hazard ($ mil.) | 2.05 |
| $\Delta V_G$ | : Cost of green moral Hazard ($ mil.) | 1.72 |
| $\Delta V_F$ | : Cost of financial moral Hazard | 0.33 |

Table 6: **Estimated Costs of Moral Hazard** This table tabulates the estiates for the costs of moral hazards $\Delta V$, $\Delta V_G$, $\Delta V_F$, based on the parameter estimates reported in Table 4.

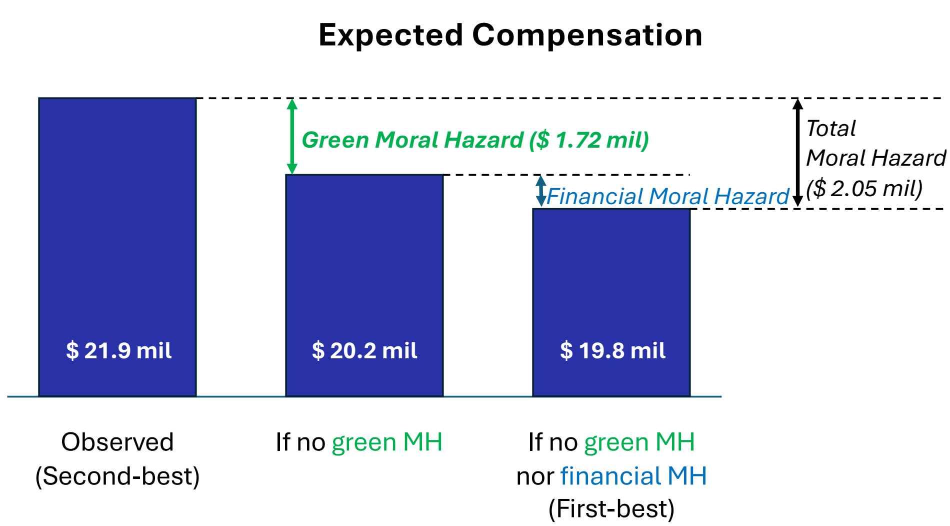
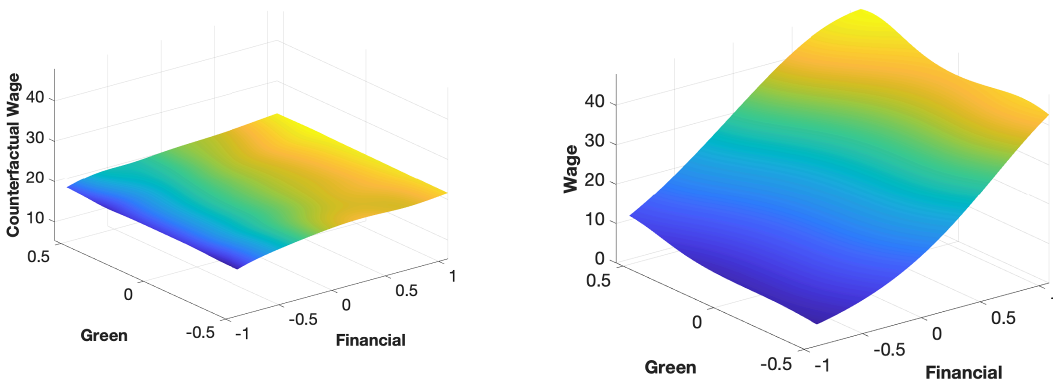



Figure 13: **Expected Compensation across Benchmarks** This figure compares the expected compensation across three benchmarks: second-best case ($E[w(x, y)]$) observed in the data, no green moral hazard case ($E[w_{cf}(x, y)]$), and first-best case ($w_{FB}$). The difference in expected compensation between second best case and no green moral hazard case gives the cost of green moral hazard ($\Delta V_G$) and that between no green moral hazard case and first-best case gives the cost of financial moral hazard ($\Delta V_F$). The total cost of moral hazard ($\Delta V$) is the sum of the two costs of moral hazard.

Figure 14 contrasts the counterfactual optimal wage $w_{cf}(x, y)$ with the observed wage $\hat{w}(x, y)$. Compared to the observed wage, the counterfactual wage is (1) less sensitive to green performance as the green project needs not be incentivized and (2) lower in level as the risk in wage and thus the required risk premium are lower.




(a) $w_{cf}(x, y)$ (b) $\hat{w}(x, y)$

Figure 14: **Counterfactual optimal wage $w_{cf}(x, y)$ (Panel a) and observed wage $\hat{w}(x, y)$ (Panel b)** This figure plots the counterfactual optimal wage $w_{cf}(x, y)$ when the green project decision $a_2$ is observable to the principal and the wage observed in the data $\hat{w}(x, y)$ (both financial effort $a_1$ and green project decision $a_2$ are unobservable), where $x$ and $y$ denote financial performance and green performance, respectively.

In the cross-sectional analysis with respect to the quality of corporate governance, I find that moral hazard costs, both green and financial, explain a greater portion of compensation for firms with weaker governance than for those with stronger governance (Table D.2). This is consistent with governance mechanism mitigating the agency friction in both the green and the financial dimension.[24]

[24]This is consistent with the findings of Giroud and Mueller (2010) and Giroud and Mueller (2011) that governance can mitigate agency friction, the effect most pronounced for firms in non-competitive industries. On the theoretical side, Chen and Wittry (2025) provide a model where weaker monitoring could lead to both high-powered financial incentive and high social externalities.

# 7 Cross-sectional and Robustness Analyses

## 7.1 Cross-sectional Analysis

In this section, I run the estimation on subsamples divided by firm characteristics, to shed light on the mechanism by understanding how the estimates differ across firms of different types.

Table 7 presents the estimates for the subsample of large firms and that of small firms, respectively. Consistent with large firms paying higher and more volatile wages, both the value of the outside option and the effort cost are higher for larger firms. The effect of financial effort is also higher for large firms, aligned with the finding that its cost is higher for larger firms as well. In contrast, the result suggests that financial compromise to improve environmental performances are costlier for smaller firms. There are two potential explanations. First, smaller firms may have less technological or human capital to reduce carbon emissions, resulting in lower efficiency.[25] This potential explanation is also consistent with green projects being more effective for larger firms. Second, the capital market may be less forgiving for smaller firms forgoing financial gains, as they are more likely to be capital-constrained.

| Parameter | | Large Firms | Small Firms |
|---|---|---|---|
| $\underline{w}$ | : Value of outside option ($mil.) | 28.456 | 11.144 |
| $c$ | : Effort cost ($mil.) | 1.058 | 0.223 |
| $\nu_1^x$ | : Financial effect of financial effort $a_1$ | 0.049 | 0.028 |
| $\nu_2^x$ | : Financial effect of green project $a_2$ | -0.006 | -0.015 |
| $\nu_2^y$ | : Green effect of green project $a_2$ | 0.026 | 0.007 |

Table 7: **Parameter Estimates across Firm Size** This table tabulates the estimates for parameters $(\underline{w}, c, \nu_1^x, \nu_2^x, \nu_2^y)$ for the two subsamples segmented by firm size (market capitalization). The "Large Firms" subsample (left column) consists of firms with size greater than the median, while the "Small Firms" subsample (right column) consists of firms with size smaller than the median.

[25] On a related note, Colonnelli et al. (2025) finds that firms' ESG practices attract highly educated employees with preference for ESG outcomes. This may explain why firms with large market capitalization can draw human capital that can better carry out emission reductions.

## 7.2 Robustness Test

Stock returns can reflect the long-term value of non-financial investments. However, stock returns may also reflect the market's preference for non-financial performance which does not necessarily translate to financial value. In order to address this concern, I use ROE, which is a measure of financial performance unaffected by the belief or preference of the capital market participants, instead of stock return.

Again, I find consistent results: green project forgoes ROE of 1.2% and reduces carbon emission intensity by 1.3%. These results reinforce my previous finding that firms do not appear to enjoy a rise in stock returns *nor ROE* when they improve environmental performance. The parameter estimates are tabulated in Table 8.

| | Parameter | Estimate |
|---|---|---|
| $\underline{w}$ | : Value of outside option (\$mil.) | 21.6 |
| $c$ | : Effort cost (\$mil.) | 0.616 |
| $\nu_1^x$ | : Financial effect of financial effort $a_1$ | 0.026 |
| $\nu_2^x$ | : Financial effect of green project $a_2$ | $-0.0118$ |
| $\nu_2^y$ | : Green effect of green project $a_2$ | 0.0129 |

Table 8: **Estimated Parameters with ROE as Financial Metric** This table tabulates the estimates for parameters $(\underline{w}, c, \nu_1^x, \nu_2^x, \nu_2^y)$ from the estimation using ROE, instead of abnormal stock return, as the financial metric.

Additionally, one might be concerned that firm characteristics correlated with the incentive structure may confound the results, because it is unlikely that the overall compensation is exogenous to firm characteristics. For instance, a certain industry may offer significantly stronger incentives on green performance than others. Therefore, I test whether the sensitivity of the wage to green performance varies with respect to key firm characteristics, using the following specification:

$$\begin{aligned} w_{it} &= \alpha + \beta_x x_{it} + \beta_y y_{it} + \beta_{FirmChar} FirmChar_{it} \\ &\quad + \beta_{xFirmChar} x_{it} \times FirmChar_{it} + \beta_{yFirmChar} y_{it} \times FirmChar_{it} + \varepsilon_{it} \end{aligned} \tag{50}$$

where $FirmChar$ denotes firm characteristics, which takes size (log asset), leverage, or industry (GIC sector). As a result, I find that the coefficient $\beta_{yFirmChar}$ on the interaction between green performance and firm characteristics is insignificant for size and leverage as reported in Table C.1 and Table C.2.[26] Similarly, the coefficients on the interaction terms with green performance are insignificant across all industries, as shown in Figure C.1. These imply that the sensitivity to green performances is *not* correlated with key firm characteristics, mitigating the aforementioned concern.

# 8 Conclusion

In this paper, I examine the extent to which CEOs are incentivized through compensation contracts to improve firms' real outcomes and the cost of implementing such incentives. I first construct a two-signal moral hazard model a là Holmström (1979), and allow the agent to separately exert financial effort that only improves financial outcomes and invest in a project that has both financial and real implications. I estimate the model to uncover counterfactual outcome distributions under only financial effort or project acceptance, as well as the cost of incentivizing CEOs to improve non-financial performance on top of exerting financial effort.

My findings show that firms are sacrificing substantial amounts of firm value to improve real, environmental outcomes. To the extent that the stock market efficiently prices environmental investments, this suggests that firms do care about real outcomes beyond profit maximization. Consistent with the steep trade-off, I find that a significant portion of executive compensation can be explained by moral hazard associated with improving real outcomes.

This paper opens a number of promising avenues of research. First avenue of research would be to study the incremental role of accounting information in contracts with incentives for real outcomes. Given that the stock price may reflect not only the economic value of non-financial performance but also the preference of investors for improvements in non-financial performance,

[26] The same can be said for the sensitivity to financial performance as well, except for size. This motivates the cross-sectional analysis with respect to size in subsection 7.1.

accounting signals could be helpful in disentangling the economic value from the preference reflected in prices. Second avenue would be to study the joint problem of trading and contracting in the context of incentives for real outcomes, as trading costs incurred to acquire sufficient shares to influence the contract would be another important cost of incentivizing firms to improve their real outcomes. Third would be examining various frictions, such as CEO's personal preference and misaligned objectives among investors, that prevents the principal from setting up a contract that optimally implements the desired investment for improving real outcomes. Fourth would be to study how incentives for real outcomes affect CEOs' actions that would affect real outcomes of other firms and how incentives for real outcomes interact across firms.

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# Appendix

# A Proofs

## A.1 Proofs for General Model

Now, I generalize the stylized framework above by (1) relaxing the distributional assumptions on the signals and (2) removing the focus on linear contracts. Specifically, as in Holmström (1979), I allow for arbitrary outcome distributions of $f_a(x,y)$ and arbitrary functional form of wage $w(x,y)$. For the purpose of identification, however, I maintain the assumption on how effort transforms the outcome distribution.

Assume that it is optimal for the principal to induce both financial effort and project acceptance: $a^* = (1,1)$. Then, the principal's problem becomes:

$$\max_{w(\cdot)} \mathbb{E}[V(x,y) - w(x,y)|a = (1,1)]. \tag{51}$$

s.t.

$$\mathbb{E}[u(w(x,y),1)|a = (1,1)] \geq \mathbb{E}[u(w(x,y),1)|a = (1,0)] \tag{IC10}$$

$$\mathbb{E}[u(w(x,y),1)|a = (1,1)] \geq \mathbb{E}[u(w(x,y),0)|a = (0,1)] \tag{IC01}$$

$$\mathbb{E}[u(w(x,y),1)|a = (1,1)] \geq \mathbb{E}[u(w(x,y),0)|a = (0,0)] \tag{IC00}$$

$$\mathbb{E}[u(w(x,y),1)|a = (1,1)] \geq u(\underline{w},(0,0)) \tag{P}$$

Given the optimal effort, the principal's problem can be further simplified as a wage minimization problem:

$$\max_{w(\cdot)} \mathbb{E}[-w(x,y)|a = (1,1)]. \tag{52}$$

subject to the incentive compatibility constraints and the participation constraint above.

Assume further that under the optimal compensation scheme, $a = (1,0)$ and $a = (0,1)$ are the best alternatives. Then, only (IC10) and (IC01) will bind and (IC00) will be a strict inequality:

$$\mathbb{E}[u(w(x,y),1)|a = (1,1)] = \mathbb{E}[u(w(x,y),1)|a = (1,0)] \tag{IC10}$$

$$\mathbb{E}[u(w(x,y),1)|a = (1,1)] = \mathbb{E}[u(w(x,y),0)|a = (0,1)] \tag{IC01}$$

$$\mathbb{E}[u(w(x,y),1)|a = (1,1)] > \mathbb{E}[u(w(x,y),0)|a = (0,0)] \tag{IC00}$$

The first order condition then gives:

$$
\begin{aligned}
1 &= \lambda\rho C e^{-\rho w(x,y)} \\
&+ \mu_{10}\rho\left(Ce^{-\rho w(x,y)} - Ce^{-\rho w(x,y)}\frac{f_{10}(x,y)}{f_{11}(x,y)}\right) \\
&+ \mu_{01}\rho\left(Ce^{-\rho w(x,y)} - e^{-\rho w(x,y)}\frac{f_{01}(x,y)}{f_{11}(x,y)}\right)
\end{aligned} \tag{53}
$$

The first order condition above provides the relation among the outcome distributions, one under the optimal effort and others under the alternative levels of effort:

$$\mu_{10}C\frac{f_{10}(x,y)}{f_{11}(x,y)} + \mu_{01}\frac{f_{01}(x,y)}{f_{11}(x,y)} = C(\lambda + \mu_{10} + \mu_{01}) - \frac{1}{\rho}e^{\rho w(x,y)} \tag{FOC}$$

Binding constraints provide:

$$C\int_x\int_y e^{-\rho w(x,y)} f_{11}(x,y)dydx = C\int_x\int_y e^{-\rho w(x,y)} f_{10}(x,y)dydx \tag{IC10}$$

$$C\int_x\int_y e^{-\rho w(x,y)} f_{11}(x,y)dydx = \int_x\int_y e^{-\rho w(x,y)} f_{01}(x,y)dydx \tag{IC01}$$

$$C\int_x\int_y e^{-\rho w(x,y)} f_{11}(x,y)dydx = e^{-\rho \underline{w}} \tag{P}$$

Moreover, as $f_{10}(x,y)$ and $f_{01}(x,y)$ are probability distribution functions, they should integrate to 1:

$$\int_x\int_y f_{10}(x,y)dydx = 1 \tag{54}$$

$$\int_x\int_y f_{01}(x,y)dydx = 1 \tag{55}$$

Finally, the prescribed effort choice should indeed be optimal for the principal:

$$\mathbb{E}[V(x,y) - w(x,y)|a = (1,1)] \geq \mathbb{E}[V(x,y) - \underline{w}|a = (0,0)] \tag{56}$$

$$\mathbb{E}[V(x,y) - w(x,y)|a = (1,1)] \geq \mathbb{E}[V(x,y) - w_{10}(x,y)|a = (1,0)] \tag{57}$$

$$\mathbb{E}[V(x,y) - w(x,y)|a = (1,1)] \geq \mathbb{E}[V(x,y) - w_{01}(x,y)|a = (0,1)] \tag{58}$$

Where $w_{10}(x,y)$ and $w_{01}(x,y)$ denote the contracts that optimally induce the alternative effort of $a = (1,0)$ and $a = (0,1)$, respectively. If the incentive compatibility constraint between $a = (1,0)$ and $a = (1,1)$ is binding under alternative contract $w_{10}(x,y)$ and that between $a = (0,1)$ and $a = (1,1)$ is binding under alternative contract $w_{01}(x,y)$, it is only marginally different from the optimal contract. Then, Equations 16 and 17 can be rewritten as:

$$\mathbb{E}[V(x,y) - w(x,y)|a = (1,1)] \geq \mathbb{E}[V(x,y) - w(x,y)|a = (1,0)] \tag{59}$$

$$\mathbb{E}[V(x,y) - w(x,y)|a = (1,1)] \geq \mathbb{E}[V(x,y) - w(x,y)|a = (0,1)] \tag{60}$$

### A.1.1 Optimal Contract

From the first order condition, the optimal wage is given as follows:

$$w(x,y) = \frac{1}{\rho} \log \left( \rho C(\lambda + \mu_{10} + \mu_{01}) - \rho C \mu_{10} \frac{f_{10}(x,y)}{f_{11}(x,y)} - \rho \mu_{01} \frac{f_{01}(x,y)}{f_{11}(x,y)} \right) \tag{61}$$

An immediate observation from the equation above is that the more likely an outcome $(x, y)$ is under actions other than the one prescribed by the contract, the lower the wage. Therefore, the highest possible wage $\overline{w}$ is rewarded to $(x, y)$ that perfectly signals $a = (1, 1)$:

$$w(x,y) \leq \overline{w} = \frac{1}{\rho} \log \left( \rho C(\lambda + \mu_{10} + \mu_{01}) \right) \tag{62}$$

It can also be seen that, given the base parameters $\rho$ and $C$, the wage function is determined by shadow costs $\lambda$, $\mu_{10}$, and $\mu_{01}$.

$\lambda$ can be readily solved for by combining the first order condition with the binding participation constraint and the incentive compatibility constraints:

$$\lambda = \frac{1}{\rho} e^{\rho \underline{w}} \tag{63}$$

The equation above is consistent with the intuition that the higher value of outside options to the agent makes it costlier to induce the agent to participate in the contract.

On the other hand, it is difficult to obtain analytical expressions for $\mu_{10}$ and $\mu_{01}$ without making additional assumptions regarding the likelihood ratios across actions. Therefore, for the analysis of the optimal contract to follow, I numerically solve for $\mu_{10}$ and $\mu_{01}$ that jointly satisfy the binding participation constraint and the incentive compatibility constraints.

In order to verify the optimality of the contract, I examine the second-order condition. Given that $\rho > 0$, $f_{11}(x, y) > 0$ for all $(x, y)$ within support, and $e^{-\rho w(x,y)} > 0$ for any real $w(x, y)$, the second-order condition can be written as:

$$\rho C(\lambda + \mu_{10} + \mu_{01}) - \rho C \mu_{10} \frac{f_{10}(x,y)}{f_{11}(x,y)} - \rho \mu_{01} \frac{f_{01}(x,y)}{f_{11}(x,y)} > 0 \tag{SOC}$$

As any wage $w(x, y)$ that violates the SOC is complex, any wage $w(x, y)$ that is real for every $(x, y)$

should satisfy the SOC.

## A.2 Proofs for Identification

For the estimation to be feasible, I make one additional assumption.

I assume that a high enough outcome in each dimension must be due to high effort in each dimension:

$$\lim_{y\to\infty}\frac{f_{10}(x,y)}{f_{11}(x,y)}=0 \tag{64}$$

$$\lim_{x\to\infty}\frac{f_{01}(x,y)}{f_{11}(x,y)}=0 \tag{65}$$

This means that extremely favorable outcomes in financial performance $x$ and non-financial performance $y$ perfectly signal financial effort $a_1$ and green project selection $a_2$, respectively. The assumption allows me to use wages for extremely favorable outcomes to infer the benchmark when moral hazard in each dimension is not present.

From the binding participation constraint, I get the first moment condition:

$$\int_x\int_y e^{-\rho w(x,y)}f_{11}(x,y)dydx=\frac{1}{C}e^{-\rho\underline{w}} \tag{66}$$

As the moment condition follows directly from the participation constraint, the immediate intuition is that the principal should reward the agent in utility for the effort cost and the outside option available to the agent.

By integrating both sides of the first order condition, I get the second moment condition:

$$\int_x\int_y e^{\rho w(x,y)}f_{11}(x,y)dydx=\rho(\lambda C+\mu_{01}(C-1)) \tag{67}$$

The intuition here is that the level of wage is determined by three factors: risk aversion, cost of participation, and cost of incentivizing costly effort. Note that, as the investment decision is personally costless, its incentive does not affect the overall level of the compensation. Instead, the incentives for investment should come from the relative distribution of the wage.

Combining the first order condition with binding incentive compatibility constraints yields the third moment condition:

$$\int_x\int_y e^{-\rho w(x,y)}f_{11}(x,y)dydx=\frac{1}{\rho\lambda C} \tag{68}$$

Given the first moment condition, this moment condition is in fact equivalent to Equation 16, the intuition of which is that inducing participation grows costly in the value of outside option.

The assumption that an extremely favorable outcome perfectly signals high effort, along with the first order condition, provides the fourth moment condition:

$$e^{\rho\overline{w}} = \rho(\lambda + \mu_{10} + \mu_{01})C \tag{69}$$

Given the analysis of the theoretical upper bound on the wage in Equation 62, this moment condition is simply stating the implicit assumption that the highest observed wage approximates the theoretical upper bound.

The assumption provides additional information on the relation between outcome distributions for extreme outcomes in each dimension:

$$(\lambda + \mu_{10} + \mu_{01})C = \lim_{y\to\infty}\left(e^{\rho w(x,y)} + \rho\mu_{01}\frac{f_{01}(x,y)}{f_{11}(x,y)}\right) \tag{70}$$

$$= \lim_{x\to\infty}\left(e^{\rho w(x,y)} + \rho\mu_{10}C\frac{f_{10}(x,y)}{f_{11}(x,y)}\right) \tag{71}$$

By combining the IC01 with the assumption that financial effort has no non-financial implication, I get the fifth moment condition:

$$\int_x\int_y e^{-\rho w(x,y)} f_{11}(x,y)dydx = \frac{1}{C}\int_x\int_y e^{-\rho w(x,y)} f_{11}(x+\nu_1^x,y)dydx \tag{72}$$

As this moment condition follows directly from the incentive compatibility condition, the intuition is simply that the improvement in financial performance due to financial effort and thus the increase in wage should compensate for the agent's effort cost.

By combining the FOC with the assumption that financial effort has no green implication, I get the following expression for the counterfactual distribution under only financial effort:

$$f_{10}(x,y) = \frac{1}{\mu_{10}C}\left(C(\lambda+\mu_{10}+\mu_{01}) - \frac{1}{\rho}e^{\rho w(x,y)} - \mu_{01}\frac{f_{11}(x+\nu_1^x,y)}{f_{11}(x,y)}\right) f_{11}(x,y) \tag{73}$$

The assumption that financial effort has no green implication, along with the assumption that extremely favorable outcome in each dimension perfectly signals effort in each dimension, provides:

$$(\lambda + \mu_{10} + \mu_{01})C = \lim_{y\to\infty}\left(e^{\rho w(x,y)} + \rho\mu_{01}\frac{f_{11}(x+\nu_1^x,y)}{f_{11}(x,y)}\right) \tag{74}$$

Let $\overline{w}(x) = \lim_{y\to\infty} w(x,y)$ and $\overline{f}_{11} = \lim_{y\to\infty} f_{11}(x,y)$ denote wage and probability density under both efforts as functions of financial performance $x$ for asymptotically high level of non-financial performance $y$. Then, the equation above provides the final set of moment conditions:

$$\frac{1}{\rho}e^{\rho\overline{w}(x)} = (\lambda+\mu_{10}+\mu_{01})C - \mu_{01}\frac{\overline{f}_{11}(x+\nu_1^x)}{\overline{f}_{11}(x)} \tag{75}$$

As the equation above provides a continuum of moment conditions, I collapse them by integrating w.r.t. x, in order to avoid overidentification:

$$\frac{1}{\rho}\mathbb{E}[e^{\rho w(x,y)}|y=\infty] = C(\lambda+\mu_{10}+\mu_{01}) - \mu_{01} \tag{76}$$

Compared to the fourth moment condition in Equation 69, intuition here is that the difference between the highest wage and the expected wage under extremely favorable non-financial outcomes can be explained by the cost of inducing financial effort.

Finally, I get a set of moment conditions for the effects of green project $a_2$, $\nu_2^x$ and $\nu_2^y$, by multiplying $x$ and $y$, respectively, and then integrating both sides of FOC:

$$\mu_{10}C(\mathbb{E}[x]-\nu_x^2) + \mu_{01}(\mathbb{E}[x]-\nu_x^1) = C(\lambda+\mu_{10}+\mu_{01})\mathbb{E}[x] - \frac{1}{\rho}\mathbb{E}[xe^{\rho w(x,y)}] \tag{77}$$

$$\mu_{10}C(\mathbb{E}[y]-\nu_y^2) + \mu_{01}(\mathbb{E}[y]) = C(\lambda+\mu_{10}+\mu_{01})\mathbb{E}[y] - \frac{1}{\rho}\mathbb{E}[ye^{\rho w(x,y)}] \tag{78}$$

The equations above show that the covariance between level of wage and each performance metric reveals the extent to which actions shift the mean of each performance metric.

Therefore, I begin by estimating $(C, \underline{w}, \lambda, \mu_{10}, \mu_{01})$ from the following five moment conditions.

$$\begin{bmatrix} \frac{1}{C}e^{-\hat{\rho}\underline{w}} \\ \hat{\rho}(\lambda C + \mu_{01}(C-1)) \\ \frac{1}{\hat{\rho}\lambda C} \\ \rho(\lambda+\mu_{10}+\mu_{01})C \\ \rho((\lambda+\mu_{10}+\mu_{01})C-\mu_{01}) \end{bmatrix} = \begin{bmatrix} \alpha \\ \beta \\ \alpha \\ \gamma \\ \delta \end{bmatrix}, \tag{79}$$

where

$$\alpha = \int_x\int_y e^{-\hat{\rho}w(x,y)} f_{11}(x,y)dydx \tag{80}$$

$$\beta = \int_x\int_y e^{\hat{\rho}w(x,y)} f_{11}(x,y)dydx \tag{81}$$

$$\gamma = e^{\hat{\rho}\bar{w}} \tag{82}$$

$$\delta = \mathbb{E}[e^{\rho w(x,y)}|y=\infty] \tag{83}$$

The first moment $\alpha$ is the agent's expected utility (reversed sign) given wage $w(x,y)$ and outcome distribution $f_{11}(x,y)$. The second moment $\beta$ captures the expected level of the wage to the agent. The third moment $\gamma$ effectively represents the theoretical upper bound of the wage. The fourth moment $\delta$ captures the expected level of wage under extremely high non-financial performance.

For a given level of risk aversion $\rho = \hat{\rho}$, I will now invert the moment conditions to obtain analytical expressions for the parameters $(C, \underline{w}, \lambda, \mu_{10}, \mu_{01})$.

From the fourth and the fifth moment condition in Equation 40, I immediately get an expression for $\mu_{01}$:

$$\mu_{01} = \frac{\gamma - \delta}{\hat{\rho}} \tag{84}$$

Substituting the above into the combination of the second and the third moment conditions, I find an expression for $C = e^{\hat{\rho}c}$:

$$C = \frac{\alpha\beta - 1 + \alpha(\gamma - \delta)}{\alpha(\gamma - \delta)} \tag{85}$$

Therefore, $c = c_{11} = c_{10}$ can be expressed as:

$$c = \frac{1}{\hat{\rho}} \log\left(\frac{\alpha\beta - 1 + \alpha(\gamma - \delta)}{\alpha(\gamma - \delta)}\right) \tag{86}$$

By substituting the above expression for $C$ into the first moment condition, I get the following for $\underline{w}$:

$$\underline{w} = -\frac{1}{\hat{\rho}} \log\left(\frac{\alpha\beta - 1 + \alpha(\gamma - \delta)}{\gamma - \delta}\right) \tag{87}$$

Substituting the above expression for $C$ into the combination of the second and the fifth moment conditions provides an expression for $\mu_{10}$:

$$\mu_{10} = \frac{1}{\hat{\rho}} \frac{\alpha(\gamma - \delta)(\delta - \beta)}{\alpha\beta - 1 + \alpha(\gamma - \delta)} \tag{88}$$

By substituting the above expression for $C$ into the third moment condition, I get the following for $\lambda$:

$$\lambda = \frac{1}{\hat{\rho}} \frac{(\gamma - \delta)}{\alpha\beta - 1 + \alpha(\gamma - \delta)} \tag{89}$$

Then, I estimate the shift parameters $(\nu_1^x, \nu_2^x, \nu_2^y)$ from the remaining three moment conditions. Note that all the parameters on the RHS of the equation (90) have been solved for.

$$\begin{bmatrix} \frac{1}{C}\int_x \int_y e^{-\hat{\rho}w(x,y)} f_{11}(x + \nu_1^x, y) dy dx \\ \hat{\rho}\mu_{10} C \nu_2^x + \hat{\rho}\mu_{01}\nu_1^x \\ \hat{\rho}\mu_{10} C \nu_2^y \end{bmatrix} = \begin{bmatrix} \alpha \\ \eta_x - \hat{\rho}(C\lambda + (C-1)\mu_{01}) m_x \\ \eta_y - \hat{\rho}(C\lambda + (C-1)\mu_{01}) m_y \end{bmatrix}, \tag{90}$$

where

$$\eta_x = \int_x \int_y x e^{\hat{\rho} w(x,y)} f_{11}(x,y) dy dx \tag{91}$$

$$\eta_y = \int_x \int_y y e^{\hat{\rho} w(x,y)} f_{11}(x,y) dy dx \tag{92}$$

$$m_x = \int_x \int_y x f_{11}(x,y) dy dx \tag{93}$$

$$m_y = \int_x \int_y y f_{11}(x,y) dy dx \tag{94}$$

By substituting the above expression for $C$ into the sixth condition, I get the following condition for $\nu_1^x$:

$$\int_x \int_y e^{-\hat{\rho} w(x,y)} f_{11}(x + \nu_1^x, y) dy dx = \frac{\alpha\beta - 1 + \alpha(\gamma - \delta)}{\gamma - \delta} \tag{95}$$

With $\nu_1^x$ pinned down, I can solve for $\nu_2^x$ and $\nu_2^y$:

$$\nu_2^x = \frac{1}{\hat{\rho}\mu_{10} C} \left(\eta_x - \hat{\rho}(C\lambda + (C-1)\mu_{01}) m_x - \hat{\rho}\mu_{01}\nu_1^x\right) \tag{96}$$

$$\nu_2^y = \frac{1}{\hat{\rho}\mu_{10} C} \left(\eta_y - \hat{\rho}(C\lambda + (C-1)\mu_{01}) m_y\right) \tag{97}$$

# B Non-financial Contract Data

In this section, I describe the characteristics of compensation contracts from the ECA in detail.

## B.1 Compensation Scheme with Nonfinancial Metrics

### B.1.1 Disclosed Metrics

Here are examples of commonly used Non-financial metrics in compensation contracts.

- Environmental Examples: GHG Emission (scope 1 and scope 2, intensity, percentage reduction), Waste Management (percentage reduction, percentage recycled), Water Consumption (intensity, freshwater withdrawal), Environmental Spills and Contamination (# of class 4+ spills or level 3+ environmental incidents), Share of Electricity from Renewable Sources (%)

- Social Examples: Employee Health and Safety (OSHA-recordable injuries, lost workdays away, severe injury and fatality rate), Diversity Equity Inclusion (Veteran representation, Women in senior management, ESG Index), Customer satisfaction, COVID 19 Response, Corporate Social Responsibility (CSR Index)

### B.1.2 Compensation Structure

Examples: Multiple Targets (Reduction of GHG emission by 6% 8% 10%, GHG intensity reduction by 16% 18% 20%, Projects in bio-fuel 1 2 3), Long-term Target (80% reduction in carbon emissions by 2030), Relative Target (Within 5% of industry leader in terms of Dow Jones Sustainability Index), Qualitative Target ("operate sustainability by delivering world-class end-to-end performance in safety resource efficiency and environmental protection")

# C Cross-sectional Variation in Wage Sensitivity

In this section, I examine how the sensitivity of the wage to financial and green performances varies with respect to various firm characteristics.

$$w_{it} = \alpha + \beta_x x_{it} + \beta_y y_{it} + \beta_{Asset} Asset_{it} + \beta_{xAsset} x_{it} \times Asset_{it} + \beta_{yAsset} y_{it} \times Asset_{it} + \varepsilon_{it} \quad (98)$$

| | (1) |
|---|---|
| | Total Pay |
| Abnormal Return × Asset | 9.673*** |
| | (5.91) |
| Emission Reduction × Asset | 7.690 |
| | (1.64) |
| Abnormal Return | -25.37* |
| | (-1.88) |
| Emission Reduction | -65.08 |
| | (-1.54) |
| Asset | 4.033*** |
| | (8.25) |
| Year FE | Y |
| N | 1419 |
| Adj-R2 | 0.309 |

*t* statistics in parentheses

* $p < .10$, ** $p < .05$, *** $p < .01$

Table C.1: **Wage Sensitivity to Performances interacted by Size (Asset)** This table reports the results from the regression shown in equation (98). t-statistics are computed with robust standard errors. Variables used in this regression are as follows: Total Pay (wage in $ million), Abnormal Return (defined as return less contemporaneous market return), Emission Intensity Reduction (defined as negative log change in emission intensity), and Asset (defined as log of lagged asset).

$$w_{it} = \alpha + \beta_x x_{it} + \beta_y y_{it} + \beta_{Lev} Levit + \beta_{xLev} x_{it} \times Lev_{it} + \beta_{yLev} y_{it} \times Lev_{it} + \varepsilon_{it} \tag{99}$$

| | (1) |
|---|---|
| | Total Pay |
| Abnormal Return × Leverage | -12.23 |
| | (-1.11) |
| Emission Reduction × Leverage | 16.56 |
| | (0.55) |
| Abnormal Return | 63.20*** |
| | (8.78) |
| Emission Reduction | 7.694 |
| | (0.37) |
| Leverage | 0.889 |
| | (0.33) |
| Year FE | Y |
| N | 1417 |
| Adj-R2 | 0.235 |

*t* statistics in parentheses

* $p < .10$, ** $p < .05$, *** $p < .01$

Table C.2: **Wage Sensitivity to Performances interacted by Leverage** This table reports the results from the regression shown in equation (99). t-statistics are computed with robust standard errors. Variables used in this regression are as follows: Total Pay (wage in $ million), Abnormal Return (defined as return less contemporaneous market return), Emission Intensity Reduction (defined as negative log change in emission intensity), and Leverage (defined as lagged liability divided by lagged asset).

$$w_{it} = \alpha + \beta_x x_{it} + \beta_y y_{it} + \sum_{Ind} \beta_{Ind} Industry_{it} + \sum_{Ind} \beta_{xInd} x_{it} \times Industry_{it} + \sum_{Ind} \beta_{yInd} y_{it} \times Industry_{it} + \varepsilon_{it} \quad (100)$$

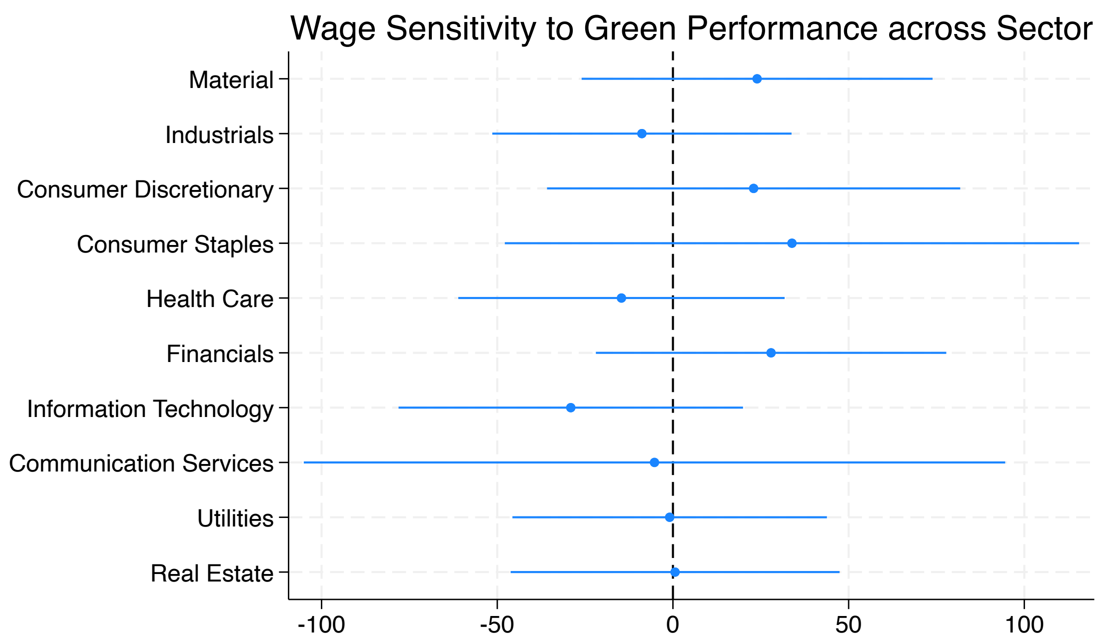


Figure C.1: **Wage Sensitivity to Green Performance across Sector** This figure plots the confidence intervals for the coefficients on the interaction between green performance and GIC sectors ($\beta_{yInd}$) from the regression shown in equation (100). The omitted sector is Energy.

# D Potential Mechanisms

In this section, I discuss the potential mechanisms for why the principal would be more willing to compromise financial gains for green outcomes. Specifically, I discuss three potential sources of this discrepancy between the principal and the marginal investor in the stock market.

First is the misalignment between the board of directors and the shareholders. In this case, the board is forwarding the green objectives to the detriment of shareholders. This is consistent with the views of Efing et al. (2024), who argue that green incentives are associated with weak corporate governance.

Second is the activism by shareholders with green preference or exposure to climate risks. In this case, the board is simply reflecting the shareholder's interest in the compensation contract to maximize the "value" to the shareholders. Contrary to the first explanation, this explanation would posit that green incentives are associated with strong corporate governance. In terms of why certain firms may have shareholders with particularly green preference, Smith (2023) shows that heterogeneous preference of investors can result in a segmented market, with green investors concentrating their investment in select firms. On the governance side, works such as Pawliczek et al. (2023) and Homroy et al. (2022) support this hypothesis.

Third is the information asymmetry between the firms' insiders and external investors. Specifically, the board might have private information suggesting that the green projects are more valuable than what the stock market investors believe. One example would be the details on the exposure of firm's operations to upcoming regulations. On a related note, Billings et al. (2022a) show that investors update their beliefs on the value of non-financial performance over time, upon learning about the risks associated with the deficiency in such performance. A related view would be that the market is not efficient in pricing the green projects. Papers such as Stroebel and Wurgler (2021) suggest that the market may substantially underestimate climate risks in asset prices.

To shed light on how the economic trade-off associated with the green project varies with respect to the quality of corporate governance, I conduct a cross-sectional analysis based on governance scores from S&P Global.[27]

Table D.1 presents the estimates for the subsample of firms with high governance scores and that of firms with low governance scores, respectively. Two points worth noting are as follows. (1) Financial gains forgone to improve green performance are high across the board. (2) The quality of governance makes the biggest difference in the efficiency of the green project. Firms with high quality of governance achieve more than double the reduction in emission intensity for a smaller cost in financial performance. Overall, the results are consistent with shareholders of firms with green incentives value green performance substantially more than the marginal investor in the stock

[27] The sample for this analysis is smaller than the main sample, as some observations are lost due to unavailability of the governance scores.

| | Parameter | High Gov | Low Gov |
|---|---|---|---|
| $\underline{w}$ | : Value of outside option ($mil.) | 30.456 | 19.114 |
| $c$ | : Effort cost ($mil.) | 1.315 | 1.193 |
| $\nu_1^x$ | : Financial effect of financial effort $a_1$ | 0.058 | 0.102 |
| $\nu_2^x$ | : Financial effect of green project $a_2$ | -0.025 | -0.030 |
| $\nu_2^y$ | : Green effect of green project $a_2$ | 0.039 | 0.017 |

Table D.1: **Parameter Estimates across Governance Scores** This table tabulates the estimates for parameters $(\underline{w}, c, \nu_1^x, \nu_2^x, \nu_2^y)$ for the two subsamples segmented by governance scores (S&P Global). The "High Gov" subsample (left column) consists of firms with governance scores higher than the median, while the "Low Gov" subsample (right column) consists of firms with governance scores lower than the median.

market. The role of corporate governance seems to be rejecting inefficient green projects. While these results do not rule out the other hypotheses, they are most consistent with the hypothesis that the contracts reflect the willingness of the shareholders to forgo financial gains to improve green performance.

| | Cost of Moral Hazard | High Gov | Low Gov |
|---|---|---|---|
| $\Delta V$ | : Cost of Moral Hazard (% of Compensation) | 5.13 | 6.81 |
| $\Delta V_G$ | : Cost of Green Moral Hazard (% of Compensation) | 2.34 | 3.54 |
| $\Delta V_F$ | : Cost of Financial Moral Hazard (% of Compensation) | 2.79 | 3.27 |

Table D.2: **Estimates of Moral Hazard Costs across Governance Scores** This table tabulates the estimates for costs of moral hazards $(\Delta V, \Delta V_G, \Delta V_F)$ for the two subsamples segmented by governance scores (S&P Global). The "High Gov" subsample (left column) consists of firms with governance scores higher than the median, while the "Low Gov" subsample (right column) consists of firms with governance scores lower than the median.

Table D.2 presents the estimated moral hazard costs for the subsample of firms with high governance scores and those of firms with low governance scores, respectively. This table shows that the cost of moral hazard, both green and financial, explain greater portion of compensation for firms with weaker governance than for those with stronger governance. This result adds validity to my estimates by reaffirming the well-established connection between agency friction and governance.

# E Intuitions from a Stylized Framework

In this section, I show a simplified version under the framework of linear compensation, exponential utility, and normally distributed performance measures, in the spirit of Holmstrom and Milgrom (1991) and Feltham and Xie (1994), to provide intuition for the generalized model used for the estimation.

**Information Structure** In this stylized LEN framework, I assume that the errors $\epsilon_x$ and $\epsilon_y$ in signals $x$ and $y$, follow a joint normal distribution. The signal structure can therefore be expressed as:

$$\begin{bmatrix} x \\ y \end{bmatrix} = a_1 \begin{bmatrix} \nu_1^x \\ 0 \end{bmatrix} + a_2 \begin{bmatrix} \nu_2^x \\ \nu_2^y \end{bmatrix} + \begin{bmatrix} \epsilon_x \\ \epsilon_y \end{bmatrix} \tag{101}$$

where components $(\epsilon_x, \epsilon_y)$ are mean-zero errors that are jointly normally distributed with a correlation of $r$:

$$\begin{bmatrix} \epsilon_x \\ \epsilon_y \end{bmatrix} \sim N\left( \begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} \sigma_x^2 & r\sigma_x\sigma_y \\ r\sigma_x\sigma_y & \sigma_y^2 \end{bmatrix} \right) \tag{102}$$

**Agent's Certainty Equivalent** Here, I focus on linear contracts $w(x, y)$ given outcome $(x, y)$:

$$w(x, y) = \alpha + \beta_x x + \beta_y y \tag{103}$$

where $\beta_x$ and $\beta_y$ are incentive coefficients for performances $x$ and $y$, respectively. Note that coefficients $(\alpha, \beta_x, \beta_y)$ sufficiently summarize the contract. Owing to the LEN setup, the agent's certainty equivalent $CE(a)$ for action $a = (a_1, a_2)$ given a linear contract $(\alpha, \beta_x, \beta_y)$ can be simplified as follows:

$$CE(a) = E[w|a] - \frac{1}{2}\rho Var(w|a) - a_1 c \tag{104}$$

$$= a_1 \underbrace{(\beta_x \nu_1^x - c)}_{\textbf{welfare impact of } a_1} + a_2 \underbrace{(\beta_x \nu_2^x + \beta_y \nu_2^y)}_{\textbf{welfare impact of } a_2} + \underbrace{\alpha - \frac{1}{2}\rho(\beta_x^2\sigma_x^2 + \beta_y^2\sigma_y^2 + 2\beta_x\beta_y r\sigma_x\sigma_y)}_{\text{constant w.r.t. action}} \tag{105}$$

From the expression above, incentive compatibility conditions for actions $a_1$ and $a_2$ are immediately clear. To induce financial effort ($a_1 = 1$), the incentive $\beta_x$ for financial outcome $x$ should at least compensate for the cost of effort:

$$\beta_x \geq \frac{c}{\nu_1^x} > 0 \tag{IC1}$$

**Contract inducing ESG Investment ("Green Contract")** To induce ESG investment ($a_2$=1), the incentive $\beta_y$ for non-financial outcome $y$ should at least counteract the disincentive caused by the financial incentive $\beta_x$:

$$\beta_y \geq \beta_x \cdot -\frac{\nu_2^x}{\nu_2^y} \tag{IC2}$$

The agent has an outside option offering $\underline{w}$ with certainty. Therefore, to ensure that the agent prefers to participate in the contract, certainty equivalent from wage should at least match the outside option:

$$E[w|a] \geq \underline{w} + a_1 c + \frac{1}{2}\rho Var(w|a) \tag{P}$$

Intuitively, the principal should reward the agent for participation, exerting effort, and taking risks. The constant portion of the wage $\alpha$ is thus determined so that the expected wage is sufficient:

$$\alpha = \underline{w} + \frac{1}{2}\rho\left(\beta_x^2\sigma_x^2 + \beta_y^2\sigma_y^2 + 2\beta_x\beta_y r\sigma_x\sigma_y\right) \tag{106}$$

Based on the constraints above, the optimal contract depends on the action that the principal seeks to implement through the contract. Suppose the principal seeks to implement both financial effort and ESG investment (i.e., $a = (1,1)$). Then, the principal's problem is reduced to minimizing expected wage subject to the incentive compatibility constraints IC1 and IC2, and the participation constraint P above:

$$\max_{\alpha,\beta_x,\beta_y} -(\alpha + \beta_x(\nu_1^x + \nu_2^x) + \beta_y\nu_2^y) \tag{107}$$

Binding incentive compatibility IC1 for financial effort $a_1$ gives incentive $\beta_x$ on financial outcome $x$:

$$\beta_x = \frac{c}{\nu_1^x} \tag{108}$$

If incentive compatibility IC2 for ESG investment $a_2$ binds, incentive $\beta_y$ on non-financial outcome $y$ is given as:

$$\beta_y = -\frac{\nu_2^x}{\nu_2^y}\beta_x \tag{109}$$

However, if IC2 does not bind, $\beta_y$ should be determined from first-order conditions. The lagrangian of the problem is then given as follows:

$$\begin{aligned}\mathcal{L} = &-(\alpha + \beta_x\nu_2^x + \beta_y\nu_2^y)\\ &+ \mu_1(\beta_x\nu_1^x - c)\\ &+ \lambda\left(\beta_x\nu_2^x + \beta_y\nu_2^y - \frac{1}{2}\rho(\beta_x^2\sigma_x^2 + \beta_y^2\sigma_y^2 + 2\beta_x\beta_y r\sigma_x\sigma_y) + \alpha - \underline{w} - c\right)\end{aligned} \tag{110}$$

Where $\mu_1$ and $\lambda$ are shadow costs of IC1 and P, respectively.

$\lambda$ is given from the first-order condition w.r.t. $\alpha$:

$$\frac{\partial}{\partial \alpha}\mathcal{L} = -1 + \lambda = 0 \tag{111}$$

Substituting $\lambda$ above into the first-order condition w.r.t. $\beta_y$ yields:

$$\frac{\partial}{\partial \beta_y}\mathcal{L} = -\rho\sigma_y^2 \left(\beta_y + r\frac{\sigma_x}{\sigma_y}\beta_x\right) = 0 \tag{112}$$

Considering both cases, when IC2 binds and when it does not, $\beta_y$ is given as:

$$\beta_y = \max\left(-r\frac{\sigma_x}{\sigma_y}, -\frac{\nu_2^x}{\nu_2^y}\right) \cdot \beta_x \tag{113}$$

The intuition for the result above is as follows. If the financial incentive $\beta_x$ is sufficient for inducing both the financial effort $a_1$ and ESG investment $a_2$ (i.e., IC2 is not binding), the role of non-financial performance $y$ in the contract is minimizing the risk borne by the agent. Therefore, if non-financial performance $y$ is positively correlated with financial performance $x$, non-financial incentive $\beta_y$ should be negative, in order to hedge the agent's exposure to financial performance $x$. On the contrary, if IC2 is binding, the sign of the non-financial incentive $\beta_y$ depends on whether the financial impact $\nu_2^x$ of ESG investment is positive or negative. On one hand, if ESG investment boosts financial performance ($\nu_2^x > 0$), non-financial incentive $\beta_y$ should still be negative to hedge the agent's exposure to financial performance $x$. On the other hand, if ESG investment is financially costly, non-financial incentive $\beta_y$ should be positive, in order to counteract the disincentive caused by the financial incentive.

Two relevant features of the data are: (1) weight on non-financial outcome is positive ($\beta_y > 0$) and (2) financial performance and non-financial performance are positively correlated ($r > 0$).[28] Reconciling these facts with the model suggests that: (1) Incentive compatibility for ESG investment, IC2, is binding and (2) ESG investment has a negative impact on financial performance. On these grounds, I assume that incentive compatibility for ESG investment binds and exclude the case in which ESG investment boosts financial performance in the analyses to follow.

This framework also allows me to compare how the optimal contract differs by how valuable ESG performance is to the principal ($k$ in Equation (1)). Given the assumptions above that ESG investment is costly, the principal would prefer to induce both financial effort and ESG investment if and only if $k$ is large enough; otherwise, the principal would only induce financial effort and avoid the costly ESG investment.

[28] One potential explanation for the positive correlation is that, for the same level of cash flow performance, investors may have preference for favorable non-financial performance and therefore reward it with stock returns.

**Contract discouraging ESG Investment ("Brown Contract")** To discourage ESG investment ($a_2$=0), the incentive $\beta'_y$ for non-financial outcome $y$ should never be strong enough to counteract the disincentive caused by the financial incentive $\beta_x$:

$$\beta'_y \leq \beta_x \cdot -\frac{\nu_2^x}{\nu_2^y} \tag{IC2'}$$

Considering both cases, when IC2' binds and when it does not, $\beta'_y$ is given as:

$$\beta'_y = \min\left(-r\frac{\sigma_x}{\sigma_y}, -\frac{\nu_2^x}{\nu_2^y}\right) \cdot \beta_x \tag{114}$$

Given the assumptions that financial performance $x$ and non-financial performance $y$ are positively correlated ($r > 0$) and that ESG investment $a_2$ is costly to the firm ($\nu_2^x < 0$), coefficient $\beta_y$ is given as:

$$\beta'_y = -r\frac{\sigma_x}{\sigma_y}\beta_x \tag{115}$$

As incentive compatibility w.r.t. financial effort $a_1$ remains the same, coefficient $\beta_x$ does not change.

Then, the optimal compensation $w'(x, y)$ that induces $a = (1, 0)$ is given as:

$$w'(x, y) = \alpha' + \beta_x x + \beta'_y y \tag{116}$$

The principal's value net of wage to the agent under the contract that induces ESG investment is as follows:

$$\begin{aligned} &E[V(x, y) - w(x, y)|a = (1, 1)] \\ &= \underbrace{\nu_1^x - c}_{\textbf{Net Value of } a_1} + \underbrace{k\nu_2^y + \nu_2^x}_{\textbf{Net Value of } a_2} - \underline{w} - \underbrace{\frac{1}{2}\rho\left(\frac{c}{\nu_1^x}\right)^2\left(\sigma_x^2 + \left(\frac{\nu_2^x}{\nu_2^y}\right)^2\sigma_y^2 - 2\left(\frac{\nu_2^x}{\nu_2^y}\right)r\sigma_x\sigma_y\right)}_{\textbf{Risk Premium}} \end{aligned} \tag{117}$$

The principal's value net of wage to the agent under the contract that *does not* induce ESG investment is as follows:

$$E[V(x, y) - w'(x, y)|a = (1, 0)] = \underbrace{\nu_1^x - c}_{\textbf{Net Value of } a_1} + \underbrace{\frac{1}{2}\rho\left(\frac{c}{\nu_1^x}\right)^2(1 - r^2)\sigma_x^2}_{\textbf{Risk Premium}} \tag{118}$$

Therefore, the principal chooses to induce ESG investment if and only if:

$$k \geq \frac{1}{\nu_2^y}\left( \underbrace{-\nu_2^x}_{\textbf{Direct Cost of } a_2} + \underbrace{\frac{1}{2}\rho\left(\frac{c}{\nu_1^x}\right)^2\left(r\sigma_x - \frac{\nu_2^x}{\nu_2^y}\sigma_y\right)^2}_{\textbf{Premium for risk added by } a_2} \right) \tag{119}$$

The equation above illustrates that the cost of implementing ESG investment to the principal is twofold: (1) direct financial cost of ESG investment and (2) compensation for the additional risk posed by the ESG incentive.

## E.1 Comparative Statics

Based on the assumption that ESG project is net costly to the firm ($\nu_x^2 < 0$), I examine how the key parameters, cost of effort ($c$), effect of financial effort ($\nu_1^x$), financial effect of ESG project ($\nu_2^x$), and ESG effect of ESG project ($\nu_2^y$) impact the cost of moral hazard in the contract that induces ESG project ("Green Contract") versus the contract that discourages ESG project ("Brown Contract"). I present the results in Figure E.1.

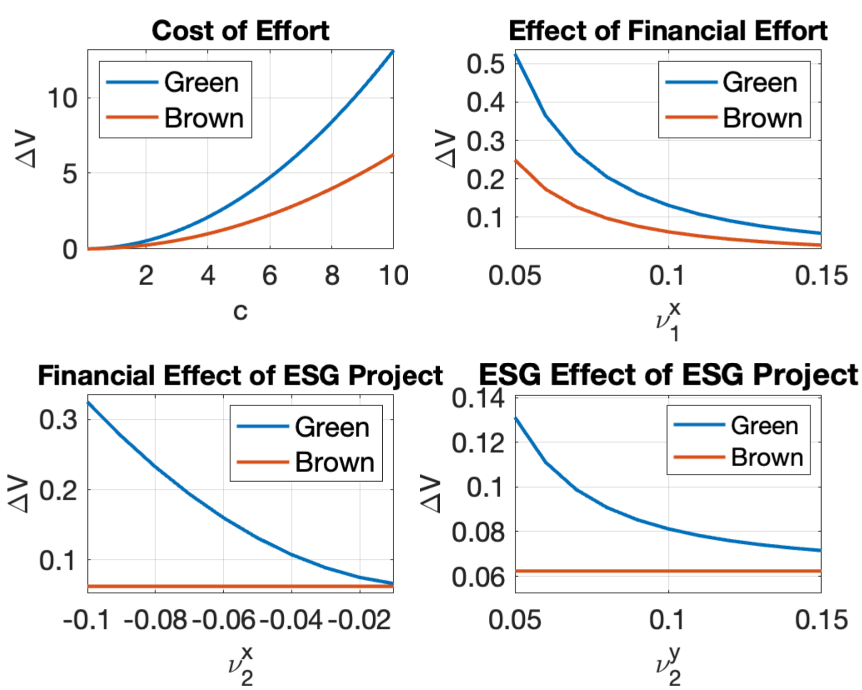


Figure E.1: **Cost of Moral Hazard w.r.t. Key Parameters** This figure plots how the moral hazard cost $\Delta V$ varies with parameters $(c, \nu_1^x, \nu_2^x, \nu_2^y)$ for "Green" contract that induces both financial effort and green project and for "Brown" contract that only induces financial effort.

The top-left panel of Figure E.1 shows that the cost of moral hazard ($\Delta V$) increases in the cost of effort ($c$) for both contracts. When the cost of effort increases, the contract becomes more sensitive to financial outcome $x$ ($\beta_x$ increases in $c$), leaving the agent more exposed to variation in $x$. This dynamic is weaker for the "brown contract", in which the non-financial outcome $y$ is used to hedge the agent's exposure to variation in $x$.

The top-right panel of Figure E.1 shows that the cost of moral hazard ($\Delta V$) decreases in the effect of financial effort ($\nu_1^x$) for both contracts. This is because $\nu_1^x$ plays the exact opposite role of $c$; higher $\nu_1^x$ means cheaper cost of effort for the same level of improvement in $x$.

The bottom-left panel of Figure E.1 shows that the cost of moral hazard decreases in the financial effect of ESG project $\nu_2^x$ (increases in the financial cost of the ESG project) for the "green contract". When the financial cost of ESG project increases, the contract becomes more sensitive to non-financial outcome $y$ ($\beta_y$ increases in the magnitude of $\nu_2^x$), leaving the agent more exposed to variation in $y$. In contrast, $\nu_2^x$ has no effect on the "brown contract", as it becomes irrelevant when the ESG project is not implemented.

The bottom-right panel of Figure E.1 shows that the cost of moral hazard decreases in the ESG effect of ESG project $\nu_2^y$ for the "green contract". This is because $\nu_2^y$ plays the exact opposite role of $\nu_2^x$; higher $\nu_2^x$ means smaller financial disincentive for the same level of improvement in $y$.