Implications of introducing investor-focused ESG reporting

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Abstract: Firms and jurisdictions are increasingly adopting ESG reporting, affecting empirical research on its consequences. We develop a model to understand the nuanced effects of ESG reporting introduction. In our model, a firm provides ESG and financial reports, which investors use to price the firm's stock, influencing management's real and reporting incentives. We characterize how ESG reporting affects ESG performance, expected cash flows, and financial misreporting. We provide conditions under which the introduction of ESG reporting discourages corporate ESG, and under which it encourages corporate ESG but lowers equity price at the same time. Comparative statics show how investor preferences (e.g., concern for ESG) and ESG efforts' cash flow implications (e.g., penalties, subsidies, physical or transition risk) affect market responses to reports, misreporting, and outcomes, suggesting effect heterogeneity in empirical tests.

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1 Introduction

Mandatory environmental, social, and governance (ESG) disclosures by corporations are becoming a reality in jurisdictions around the world.[1] Companies have also voluntarily adopted ESG reporting practices, publishing sustainability reports guided by various third-party standard setters.[2] The effects of the adoption of ESG reporting, whether voluntary or mandatory, are of interest to policy-makers, standard-setters, researchers, and corporate managers.[3] But despite the good intentions of the various parties behind the spread of ESG reporting, many of the potential effects of ESG reporting—on cash flows, stock prices, greenwashing, financial misreporting incentives, and ESG performance—are nuanced and subject to potential unintended consequences.

To better understand the potential effects and implications of ESG reporting, we develop a stylized model that captures what we believe are the key forces relevant to ESG reporting in a capital market setting. A publicly traded firm faces different types of investors: all investors value cash flows, and a subset of investors also directly value ESG performance. The firm's manager, who cares about the firm's stock price, takes an action that affects both ESG and cash flow performance,[4] and issues financial and ESG reports to investors. The action, which we label as an ESG action, improves ESG performance but can have cash flow

[1] For instance, the Corporate Sustainability Reporting Directive in the European Union has entered into force (European Commission, 2024); the SEC passed a rule requiring certain climate-related disclosures starting in 2026, though this rule has since been stayed (SEC, 2024; Binnie, 2024); climate disclosure and assurance in California will be effective for large companies by 2026; (KPMG, 2024); in China, three main stock exchanges will require companies to publish sustainability reports by 2026 (Lee, 2024). Note that while we use the term ESG, our analysis can be also interpreted as capturing aspects of corporate sustainability, corporate social responsibility (CSR), specific dimensions of environmental or social performance, or other externalities potentially valued by some investors.

[2] These standard-setters and guidance-providers include the Taskforce on Climate-Related Financial Disclosure (TCFD), International Sustainability Standards Board (ISSB), Global Reporting Initiative (GRI), and others.

[3] For discussions of the recent ESG literature, see Grewal and Serafeim (2020), Christensen et al. (2021), and Friedman and Ormazabal (2024). For a study of the impact of the voluntary adoption of an ESG reporting standard, see Bochkay et al. (2023).

[4] While we focus on a single ESG-relevant action, we include a second cash-flow term that captures cash flows that are unaffected by the manager's ESG action. For instance, an oil company executive might choose how much to incorporate carbon capture and storage into its production process. This costly activity affects the company's ESG performance and cash flows, but there are many other components (such as global oil prices) that determine the firm's profits.

effects that are either positive (e.g., a low-cost renewable electricity source) or negative (e.g., a high-cost carbon-capture technology).

Our first set of analyses explores a benchmark in which the firm issues only a financial report regarding cash flows, consistent with the current mandatory reporting environment in the U.S. and for many firms globally. Absent ESG reporting, investors use the financial report to learn about both cash flows and the ESG performance of the firm: cash-flow-only-interested investors learn about financial performance; ESG-interested investors make inferences about the firm's ESG performance, through its relation with reported cash flows. While potentially obvious ex post, it is worth noting that because of this inference, ESG-interested investors are not entirely in the dark absent ESG-focused reports. The price reaction to the financial report combines these two learning channels and feeds back into the manager's effort choice. Managers adjust their efforts both to influence cash flows and to influence the inference that ESG-interested investors make about ESG performance from the cash flow information contained in financial reports.

Next, we introduce ESG reporting. Because investors can learn about ESG activities from the financial report, the ESG report provides an incremental rather than a completely novel signal about the manager's effort. Furthermore, because the ESG report is informative about managerial actions that affect cash flows, the ESG report is informative about cash flows as well. As with any additional signal, the ESG report can thus change how investors use the financial report, i.e., how they update beliefs based on it and consequently how prices react to it. Focusing on stock price reactions to the report, which in turn provide managerial incentives, the introduction of ESG reporting changes the firm's price through three main channels. First, investors use the additional report to learn about the ESG effort that affects the firm's cash flows and ESG output. This learning is reflected in a price response to the ESG report itself. Second, the information conveyed by the ESG report changes the risk premium and the price response to the financial report, since the financial and ESG reports

are both informative about the manager's efforts.[5] Finally, the introduction of the ESG report affects price through its effect on the manager's equilibrium choice of ESG action. Investors anticipate the ESG report's effects on the manager's efforts and reports and, as a result, change their expectations of cash flows, ESG output, and financial and ESG reports in equilibrium, altering the price.

To provide guidance on how newly introduced ESG reporting can affect firms, we compare equilibria for the financial-report-only and financial-and-ESG-reports settings. The main insight is that the effects of ESG reporting on price responses, ESG, and cash flow performance hinge on how the manager's ESG effort affects firm cash flows. We identify three regions, based on the sign and magnitude of the ESG-cash-flow relation relative to other important parameters of the model (e.g., the fraction of investors who value corporate ESG performance).

First, if the manager's ESG effort is cash-flow-improving (i.e., ESG and cash flows are complementary), the ESG and financial reports are positively correlated signals about the manager's action. The introduction of the ESG report is thus similar to the introduction of a second financial report and dampens the price response to the extant financial report. For a cash-flow-positive ESG effort, price responses to both higher ESG and higher financial reports are unambiguously positive. As a result, the manager chooses a higher ESG effort, increasing expected cash flows, ESG performance, and the firm's stock price.

Second, on the other extreme, the ESG effort is highly damaging to cash flows (i.e., there is a large trade-off between ESG performance and cash flows). The price response to the ESG report becomes negative in this case because the cash flow effects of ESG performance outweigh the ESG effects from a representative investor's perspective. Since the ESG and financial reports are negatively correlated, and the response to the ESG report is negative, the market again effectively treats the (negative) ESG report as another cash flow signal. Consequently, after ESG reporting is introduced, the price response to the financial report

[5]Note that even if the ESG report perfectly revealed the manager's action, investors would still react to the financial report to learn about non-ESG-related components of the firm's cash flows.

decreases. Reduced market reaction to the financial report and negative reaction to the ESG report jointly disincentivize the ESG action. The manager chooses a lower level of ESG-improving effort, leading to lower expected ESG but higher expected cash flows. The manager's choice is again aligned with the representative investor's, and the firm's price increases after the introduction of ESG reporting. That is, the only difference to the setting with a cash-flow-improving ESG effort is that introducing the ESG report lowers the expected ESG performance; expected cash flows and the firm's stock price still increase.

Finally, the implications of ESG reporting change in the middle region, where the effect of the ESG effort on the firm's cash flows is moderately negative. In this region, despite the adverse effect of the ESG action on cash flows, ESG-interested investors cause the price response to the ESG report to remain positive. However, different from the other two regions, the price response to the financial report increases. The reason is that ESG investors now have two separate signals about negatively correlated outcomes. Separating the two dimensions implies that they can infer most of the variation in ESG effort from the ESG report and then learn more about cash flows from the financial report. Since the ESG effort is not too cash-flow-negative, the higher price response to the ESG report outweighs the higher price response to the financial report, and the manager chooses a higher ESG effort, resulting in higher ESG and lower cash flow performance. Importantly, and perhaps unexpectedly, for the moderately cash-flow-negative ESG effort, after ESG reporting is introduced, the firm's price can decrease in expectation. The decrease occurs because the manager's choice to prioritize ESG over cash flows sometimes disagrees with the choice of a representative investor, who would prefer the manager to prioritize cash flows and choose a lower ESG effort. We provide an explicit cross-sectional condition under which price decreases and show that this is more likely for firms where the financial report is more informative about non-ESG related cash flows.

Our results so far suggest caution when interpreting a few potentially important effects of ESG reporting. First, changes in the price response to financial reports should not be seen

as prima facie evidence of changes in the quality of financial reporting—in each scenario above, we held the quality of financial reporting fixed when introducing the ESG report. Second, a positive stock price reaction to the introduction of ESG reporting does not imply that investors, on average, would like greater ESG efforts from firms. This is explicitly not the case in the third scenario, where the ESG has a moderately negative cash-flow impact. Third, the market response to ESG news may not be directly informative about whether the underlying activity is good for ESG or financial performance.

The fact that the impact of ESG reporting hinges on the cash flow-ESG trade-off implies non-trivial policy implications as well. If a policy-maker's goal is to provide cash flow relevant information to investors, then mandatory ESG reporting is more justifiable when the cash flow effects are larger, whether positive or negative. If the goal is instead to encourage ESG activities, such as greenhouse gas emissions reductions, then, perhaps counterintuitively, ESG reporting should be curtailed for activities with very negative cash flow implications.

In addition to real effects of introducing ESG reporting, we study implications for financial misreporting and greenwashing (i.e., misreporting of ESG performance). We find that the ESG effort and greenwashing always complement each other, implying that corporations' exaggeration of their ESG performance can in fact signal that their actual ESG efforts are also higher.[6] Financial misreporting and the ESG effort may be complements or substitutes: if the ESG effort is cash flow-positive, both financial misreporting and ESG effort increase in the market response to the financial report; if the ESG effort is cash flow-negative, financial misreporting increases but the ESG effort decreases in the market response to the financial report.

Finally, we derive empirically testable predictions for how changes in investor composition, cash flow-ESG trade-offs, and greenwashing opportunities affect price responses, cash flow and ESG performance, financial misreporting, and greenwashing. These can be relevant when considering cross-sectional or time-series variation in investor base (e.g., holdings from

[6]For an example of investors and regulators realizing this phenomena, see (AMBA, 2023).

green asset managers), fiscal policies (e.g., taxes and subsidies related to ESG activities), and the monitoring of ESG reporting (e.g., board ESG specialists and audits of ESG reports).

2 Literature Review

We address regulators' and researchers' call to improve our understanding of trade-offs related to characteristics of managers' reports about internal and external effects of their ESG actions (Christensen et al., 2019; Grewal and Serafeim, 2020; Bochkay et al., 2023). Our model broadly combines four strands of literature. First, our focus on a setting with ESG and financial reports ties our analysis to prior studies incorporating multiple performance measures (e.g., Holmstrom and Milgrom, 1991; Datar et al., 2001). Second, as in the literature on earnings management (e.g., Dye and Sridhar, 2004; Fischer and Verrecchia, 2000), our focal firm discloses reports that may not be truthful. Third, our model features feedback effects whereby price responses to reports encourage both real activities and reporting choices (e.g., Kanodia, 2007). Finally, some investors who receive the reports incorporate their beliefs about the firm's ESG when forming their demand, similar to Pástor et al. (2020), Friedman and Heinle (2016), and additional studies discussed in greater detail below. Concurrent studies have also incorporated real effects of capital market responses on firms' ESG choices (see, e.g., Goldstein et al. (2022) and Xue (2022), which feature rational expectations equilibria).

Our model extends the literature on earnings management (e.g., Dye and Sridhar, 2008) by allowing a manager to manipulate the report of firms' ESG, i.e., to engage in greenwashing. This allows us to examine how greenwashing and financial misreporting interact. We analyze the manager's reporting strategies as functions of parameters capturing features related to investor preferences for ESG, misreporting opportunities and incentives, productivity parameters, and the importance of ESG and non-ESG factors to the firm's cash flows.

Several studies provide evidence that individuals value the societal impacts of their invest-

ments. For example, Krueger et al. (2020) show that many institutional investors recognize the importance of climate risks for their portfolios' cash flows. Similarly, Bauer et al. (2021) find that two-thirds of pension fund members they surveyed are willing to sacrifice some financial benefits to invest in companies whose goals are aligned with the United Nations' Sustainable Development Goals (SDG). Heath et al. (2023) show that Socially Responsible Investment (SRI) funds tend to choose portfolio firms that perform well on ESG dimensions. Bonnefon et al. (2022) provide evidence suggesting that investors obtain "warm glow giving" utility when their investments are aligned with social values, and Barber et al. (2021) demonstrate this phenomenon for venture capital investors. Bolton and Kacperczyk (2021) provide further evidence of tradeoffs between ESG and market performance in investors' preferences.

The pricing of companies' non-financial performance has received much recent academic interest. For example, Pástor et al. (2020) show that investors' tastes for green holdings affect asset prices in equilibrium, and their effects on returns can be represented by a green factor. Zerbib (2020) develops an asset-pricing model where ESG performance is priced due to the impact of two investor groups: those that exclude certain assets from their investment options and those that internalize private costs of externalities in their expected returns. These investors cause two types of premia to occur: taste premia and exclusion premia. Pedersen et al. (2020) analyze an economy where the ESG score contains information related to firm fundamentals and some investors have preferences about firms' non-financial performance. They show that in equilibrium, prices of assets satisfy a four-fund separation theorem incorporating both financial and ESG performance. Chowdhry et al. (2018), Oehmke and Opp (2019), Friedman and Heinle (2021) derive conditions for impact investment to affect social outcomes when some investors value impact as well as cash flows.

There is relatively little existing theoretical research on greenwashing. Lyon and Maxwell (2011) provide a model of greenwashing based on discretionary disclosure of favorable signals (e.g., Jung and Kwon, 1988), in contrast to our model of greenwashing as reporting bias with

uncertain costs, which interacts with financial reporting bias. Despite the relative paucity of theoretical research, there exists rich empirical evidence for firms' greenwashing or providing inappropriate information on their ESG activities (e.g., Bingler et al., 2021; Basu et al., 2021; Delmas and Burbano, 2011; Marquis et al., 2016), as well as numerous examples from the popular and business press (e.g., Brogger and Marsh, 2021; Kowsmann and Brown, 2021).

A separate literature has focused on the materiality of ESG disclosures (e.g., Khan et al., 2016; Jebe, 2019). For example, Amel-Zadeh and Serafeim (2018) report survey evidence that mainstream investment organizations primarily use ESG information because of its relevance to investment performance, ahead of client demand and ethical considerations. Although Moss et al. (2020) find no evidence of retail investors reacting to ESG press releases, Moss et al. (2022) show that stock prices respond to ESG performance information. Materiality implies "relevant to investor decision-making," and can be evaluated based either on relevance to fundamentals, i.e., future cash flows or discount rates, or based on investor responses to ESG information releases. The Sustainability Accounting Standards Board (SASB, now part of the IFRS Foundation's International Sustainability Standards Board) has promulgated industry-specific sustainability standards that focus on materiality, while the SEC recently finalized a climate disclosure rule mandating disclosure of certain items based on materiality considerations.[7] Our model, by clearly delineating cash flow relevance, ESG relevance, and investor response, allows us to show how focusing on different definitions of materiality in designing ESG reports can affect prices, greenwashing, and corporate ESG efforts.

An issue related to investor-focused materiality is on how trading activity and investor engagement affect firms' ESG performance. Landier and Lovo (2020) show how the policy of an ESG fund forces companies to internalize (at least partially) their externalities. An ESG fund's optimal strategy is to invest in firms with the strongest capital search frictions and most inefficient externalities. Green and Roth (2021) derive optimal strategies for social

[7]For further details on the SASB standards and SEC disclosure rules, respectively, see SASB (2024) and SEC (2024). Note that the SEC's climate disclosure rule was stayed shortly after finalization Binnie (2024).

investors to maximize social welfare in an environment of competition between commercial and social investors. De Angelis et al. (2020) show how companies' greenhouse gas emissions can be reduced through the increase in the cost of capital for those companies, wherein the cost of capital becomes more sensitive to emissions as the share of green investors and environmental stringency increase.[8]

Our contribution to these streams of literature is through explicitly modeling firms' reporting of ESG activities as well as potential greenwashing. We show how in equilibrium, a firm's price is sensitive to its ESG report and its financial report. We analyze how price and its sensitivity to the reports vary with the cash flow-ESG trade-off and investor composition and show how this sensitivity in turn affects managers' real and reporting choices.

Our study supports and offers a mechanism to explain existing empirical findings. We demonstrate how investors, even if they do not inherently value ESG, can learn cash-flow relevant information from ESG reports, consistent with Amel-Zadeh and Serafeim (2018)'s evidence that one of the most frequent reasons for investors using ESG data is to improve financial performance. The introduction of value-relevant ESG disclosures in our model can on average cause positive price reactions, consistent with the results of Arif et al. (2022). Matsumura et al. (2014) find that investors can "penalize" firms for low ESG performance; this penalty is dampened if companies provide more detailed ESG disclosures.

Second, our results are consistent with prior studies' evidence on the real effects of ESG disclosures. A number of studies show that companies subject to mandatory or standardized ESG disclosure regimes reduced their emissions (Chen et al. (2018), Grewal et al. (2022), Downar et al. (2021), Yang et al. (2021), Bochkay et al. (2023)) and improved ESG performance (Fiechter et al. (2022), Christensen et al. (2019)), consistent with our prediction that the introduction of ESG reporting can increase expected ESG performance as long as the effect of ESG performance on the firm's cash flows is not too negative. Consistent

[8]Several studies have noted potential unintended consequences of disclosure and capital market pressure related to ESG performance, including shifting of emissions to geographic areas, subsidiaries, suppliers, peer firms, or unlisted competitors where they are less likely to be scrutinized Bartram et al. (e.g., 2022); Hartzmark and Shue (e.g., 2022); Mahieux et al. (e.g., 2023).

with our setup, Yang et al. (2021) find that stock prices can motivate firms to change their ESG-related behavior. Wang (2022) finds similar results when focusing on lending-related incentives: corporate U.S. borrowers of non-U.S. banks that are exposed to ESG disclosure regulations improve their environmental and social performance.[9] Thomas et al. (2022) highlight the trade-off between cash flows and ESG performance that some companies face, and how the pressure to beat a financial reporting benchmark pushes the firms to choose financial performance over non-financial.

Finally, we demonstrate how ESG reporting can lead to an undesired outcome—companies overstating their ESG performance, or greenwashing. Raghunandan and Rajgopal (2022) consider mutual funds and show that funds that self-label as ESG end up holding a portfolio of companies with worse ESG performance but higher ESG scores. The disconnect between how funds' ESG performance is measured (investment portfolio's ESG score) and what this performance actually is makes the ESG-labelled mutual funds maximize the metric they report rather than their real ESG outcome.

3 Model setup

Our model features a firm whose manager makes production and reporting choices and a continuum of investors who allocate their wealth between shares in the firm and a risk-free asset that is assumed to have a gross return of 1. The timeline is such that the manager's choices are made first. These result in reports provided to investors, who trade the firm's shares in a competitive market and thus establish a stock price. Finally, firm performance is realized and all parties consume.

The manager chooses the level of ESG effort, $e \in \Re$, which affects the firm's cash flows and ESG performance. While we use the term 'effort' throughout, it can also be read as an action or investment, and we allow it to be positive, negative, or zero (e.g., level of net carbon

[9] While we do not focus on debt channels per se, the intuition behind our results applies for both equity and debt securities.

abatement investment, net efforts towards equitable and inclusive hiring, or the degree of anti-corruption controls). In particular, the firm's cash flows are $\tilde{x} = \theta e + \tilde{\varepsilon}_x$, with $\theta \in \Re$ and $\tilde{\varepsilon}_x \sim N(0, \sigma_x^2)$. The firm's ESG performance is $y = \eta e$, with $\eta > 0$. The productivity parameters, θ and η, are constants known by all actors. We restrict $\eta > 0$ so that the action can be interpreted as ESG-improving, sustainable, or "green." In contrast, θ can be positive or negative, which gives us the flexibility to consider cash flow enhancing ESG efforts (e.g., efficiency improvements) as well as cash flow detracting efforts (e.g., costly carbon capture and storage). Put another way, $\theta > 0$ implies complementarity between ESG and cash flows, summarized by the scalar e, while $\theta < 0$ implies efforts where cash flow and ESG performance are substitutes. The stochastic $\tilde{\varepsilon}_x$ captures factors that affect cash flows but are not related to the firm's ESG performance, i.e., non-ESG cash flows.

We assume that the continuum of investors has unit mass and that the supply of shares is fixed at 1. The risk-free asset (money) serves as the numeraire in which investors can borrow or lend. It is supplied elastically, such that its price and gross return, both 1, are not affected by demand.

Investors are heterogeneous with regard to their preferences over the firm's ESG performance but have homogeneous preferences with regard to cash flows. Specifically, although all investors value cash flows and are risk averse with respect to their cash holdings, a λ-fraction of investors also value the firm's ESG performance.[10] To simplify the analysis, we assume that the ESG-concerned investors are risk-neutral with respect to ESG.[11]

Let q_i and l_i denote the amount of shares and money, respectively, held by investor i. Denote type-1 investors as those who care only about cash flows. Their utility is $u_1 =$

[10] We treat λ as an exogenous parameter, and discuss comparative statics on λ in Section 7.1. Empirical evidence, discussed above, shows that some investors exhibit preferences for non-financial dimensions of portfolio holdings. Future work might consider the drivers of λ, which could include, for instance, the potential for λ to depend on the availability of information about firms' ESG performance.

[11] There is little evidence on the degree of risk aversion with respect to ESG outcomes. Our assumption of risk neutrality is made here to keep the model tractable and ease interpretation of the effects we identify. It sidesteps issues of ESG risk sharing between investors, as a risk-efficient allocation would have the non-ESG concerned type 1 investors hold all of the ESG risk. Broadly, adding risk aversion in ESG performance would introduce additional tradeoffs that we leave for future work.

$-exp[-\rho(q_1\tilde{x} + l_1)]$. Type-2 investors, who also value the firms' ESG performance (in risk-neutral expectation), have utility defined by $u_2 = -exp[-\rho(q_2(\tilde{x} + E[\tilde{y}|\Omega]) + l_2)]$. Ω is the information on which investors condition their expectations.

The firm's manager is interested in maximizing the firm's stock price but bears a cost related to her productive and reporting choices. In particular, the manager has a private preference for her ESG effort captured by $\frac{c_e}{2}(e - \phi)^2$, where $\phi \sim N(\bar{\phi}, \sigma_\phi^2)$ captures her ex ante stochastic private ESG preference based on, for instance, personal preferences, social pressure, or compensation incentives (based on measures besides stock price or the modeled reports). Including a privately observed ESG preference implies that the manager's effort choice cannot be perfectly anticipated by investors and, thus, that investors use the provided information to update their beliefs about the manager's choices. We allow $\bar{\phi}$ to be positive, negative, or zero, as one type of manager may, in expectation, prefer emissions reduction while another may equate such efforts with undesirable political posturing.

Crucially, investors do not observe the manager's realized preferences, though the expectation, $\bar{\phi}$, and variance, σ_ϕ^2, are common knowledge, as are the other parameters (e.g., η, θ, λ, ρ, σ_x^2, and other cost and distributional terms introduced below). The manager's private observation of ϕ induces randomness in her effort, e, which makes it impossible for investors to infer her equilibrium efforts with certainty.[12] In equilibrium, investors in our model use reports to learn about the manager's effort. We assume that all random variables are independent, including reporting incentive parameters introduced below. Our main model will

[12]The private preference for ESG effort could be affected by unmodeled compensation (see Krueger et al. (2020),Walker (2022), and Cohen et al. (2023) for empirical evidence), which may only be partially observable or understandable to outside investors. Cohen et al. (2023) study international practices for compensation of executives tied to ESG performance, their drivers, and consequences. Walker (2022) emphasizes the economic importance of ESG-related capital market incentives relative to ESG-related contractual compensation incentives in practice. Nonetheless, we can interpret $\bar{\phi}$ as capturing compensation incentives known by investors and σ_ϕ^2 as capturing compensation incentives over which investors are uncertain, as long as the incentives are not based on stock price or the financial and ESG reports, as these would introduce feedback effects that would alter the equilibrium. Introducing such incentives is a potentially interesting direction for future work. However, modeling the equilibrium determination of these incentives by, for instance, the board of directors, requires an explicit formulation of the board's objective with respect to financial and ESG performance. Our approach is to take price incentives as given and incorporate managerial preferences as a random action shifter, ϕ. See Bonham and Riggs-Cragun (2022) for a theoretical model of ESG-related compensation.

feature both ESG and financial reports.[13] This allows us to consider ESG reporting in the context of the current landscape of corporate reporting, in which financial reporting is well established.

Investors learn about the firm's financial and ESG performance from two reports: about cash flows and about ESG performance. The financial report, f, provides a noisy measure of the firm's cash flows, x: $f = x + \varepsilon_f$, with $\varepsilon_f \sim N\left(0, \sigma_f^2\right)$. The noise in the financial report, ε_f, captures any exogenous factors that prevent the report from truthfully revealing the company's actual cash flows. Paralleling the financial report, the ESG report, r, provides a noisy measure of the firm's ESG performance, y. As such, the ESG report disclosed to investors is $r = y + \varepsilon_r$, where $\varepsilon_r \sim N\left(0, \sigma_r^2\right)$ represents exogenous idiosyncratic noise.

The timeline is as follows: at $t = 0$, the manager observes her private preference, ϕ, and chooses ESG effort, e, to maximize the following utility function, which consists of stock price net of the costs of the ESG action.[14]

$$u_m = p - \frac{c_e}{2}\left(e - \phi\right)^2. \tag{1}$$

At $t = 1$, the financial and ESG reports, f and r, are disclosed to investors. Investors then trade in the shares and establish the stock price, p. Specifically, stock price is set to ensure that the market for shares clears in a competitive Walrasian equilibrium with market-clearing condition: $(1 - \lambda)\, q_1 + \lambda q_2 = 1$. At $t = 2$ cash flows are paid out and ESG performance is revealed.

In the sections that follow, we first present the equilibrium with only the financial report

[13] Moss et al. (2022) empirically examine heterogeneity in market responses to ESG performance news depending on whether ESG news is released during an earnings announcement period or at a different time. The joint study of ESG and earnings performance news is germane to our setting. Though we do not specifically address issues of heterogeneous timing of information releases, implications for price responses when one report to come out before the other can be viewed as a mild theoretical extension of results we present in Sections 4 and 5.

[14] As noted above, we can interpret distributional characteristics of ϕ as a reduced-form representation of non-price compensation incentives. A weight of 1 on price in equation 5 is without loss of generality, relative to other weights, since the cost parameter, c_e, can be viewed as scaling the importance of effort cost relative to the importance of stock price.

as a benchmark, and then provide the equilibrium with both financial and ESG reports. In both equilibria, investors use the reports to update their beliefs about the relevant outcomes. Type-1 investors use the available information to learn about cash flows, which means learning about the ESG effort, e, and the non-ESG component of cash flows, ε_x^2. Type-2 investors do the same but are additionally interested in the ESG implications of the ESG effort, given by $y = \eta e$. We introduce financial misreporting and greenwashing explicitly in Section 6.

4 Equilibrium with only financial reporting

The lemma below summarizes the equilibrium price, action, and financial report in a world in which the firm manager only chooses ESG effort and only the financial report is issued. The equilibrium represents an economy without mandated ESG reporting and thus serves as a benchmark to analyze how the introduction of ESG reporting may affect capital market and real outcomes.[15]

Lemma 1 *In the equilibrium with only the financial report without misreporting, the stock price and manager's effort are given by*

$$\begin{aligned} p^{\dagger} &= E_x^{\dagger} + \frac{\sigma_{x|f}^2}{\sigma_f^2}\left(f - E_f^{\dagger}\right) + \lambda\left(E_y^{\dagger} + \frac{\sigma_{xy|f}}{\sigma_f^2}\left(f - E_f^{\dagger}\right)\right) - \rho\sigma_{x|f}^2 \text{ and} \\ e^{\dagger} &= \phi + \frac{\varphi_f^{\dagger}\theta}{c_e} \end{aligned}$$

where $E_j^{\dagger} = E[j]$ are prior means in equilibrium. The price response to the financial report is

$$\varphi_f^{\dagger} = \frac{\partial p^{\dagger}}{\partial f} = \left(\frac{\sigma_{x|f}^2}{\sigma_f^2} + \frac{\lambda\sigma_{xy|f}}{\sigma_f^2}\right) = \frac{\sigma_x^2 + \sigma_\phi^2\left(\theta^2 + \lambda\theta\eta\right)}{\sigma_f^2 + \sigma_x^2 + \theta^2\sigma_\phi^2},$$

and the conditional variance terms are given by $\sigma_{x|f}^2 = Var(x|f) = \sigma_f^2 \frac{\sigma_x^2 + \theta^2\sigma_\phi^2}{\sigma_f^2 + \sigma_x^2 + \theta^2\sigma_\phi^2}$ and $\sigma_{xy|f} = Cov(x, y|f) = \frac{\theta\eta\sigma_f^2\sigma_\phi^2}{\sigma_f^2 + \sigma_x^2 + \theta^2\sigma_\phi^2}$.

[15] This benchmark model is similar in spirit to models explored in Lambert (2001, Section 3.3.5) and Feltham and Xie (1994, Section V), though these focus on using market price as a contractual performance measure in a multi-action agency.

In the equilibrium described by Lemma 1, the price reflects four main components. The first is the prior expectation of cash flows, $E_x^\dagger = \theta E\left[e^\dagger\right] + E\left[\varepsilon_x\right] = \theta\bar{\phi} + \theta^2\frac{\varphi_f^\dagger}{c_e}$, which is increasing in the price response to the financial report, $\varphi_f^\dagger$. The second term reflects investors' use of the financial report to update beliefs about cash flows, $\sigma_{x|f}^2\left(f - E_f\right)/\sigma_f^2$. The third term captures type 2-investors' expectations of ESG performance, conditional on the financial report, $E_y^\dagger + \sigma_{xy|f}\left(f - E_f^\dagger\right)/\sigma_f^2$, which are weighted in price by the fraction of ESG investors present in the market, λ. The fourth term captures the risk premium, $\rho\sigma_{x|f}^2$, or the discount to price due to risk averse investors bearing cash flow risk.

Note that the financial report plays multiple roles. First, it provides information about the non-ESG component of cash flows, ε_x. This information is useful to all investors and allows them to update their beliefs about expected cash flows and the variance of cash flows. Second, the financial report provides information about the firm's ESG efforts, which are stochastic from investors' perspective because investors do not observe the manager's private preferences, ϕ. Learning about the ESG efforts is useful to all investors as long as $\theta \neq 0$, such that ESG efforts affect cash flows, and is incrementally useful to type-2 investors due to the effects on ESG performance. Fundamentally, investors' response to the financial report is driven by the degree to which it contains information about relevant cash flow and ESG outcomes as opposed to reflecting the idiosyncratic noise in the financial report.

The last primary effect of the financial report is what may be called a real effect. The dependence of the stock price on the report and the manager's stock price concern jointly affect the manager's equilibrium effort incentives, which in turn affect real cash flows and ESG performance. This effect is borne out in the $\varphi_f^\dagger\theta/c_e$ term in the manager's equilibrium effort. Note that this term is not ex ante stochastic. Rather, it depends on the sensitivity of stock price to the financial report, $\varphi_f^\dagger$, which is in turn a known function of model parameters.

Corollary 1 *In the financial report only setting without misreporting, the sensitivity of price to the financial report*

1. *increases (decreases) in the fraction of type-2 investors, λ, when θ is positive (negative),*

i.e., $\frac{d\varphi_f^\dagger}{d\lambda} = \frac{\sigma_\phi^2 \theta \eta}{\sigma_f^2+\sigma_x^2+\theta^2\sigma_\phi^2} \propto \theta$, *and*

2. *increases (decreases) in the cash flow effects of ESG efforts,* θ*, when* $2\theta\sigma_f^2+\lambda\eta\left(\sigma_f^2+\sigma_x^2-\theta^2\sigma_\phi^2\right)$ *is positive (negative), i.e.,* $\frac{d\varphi_f^\dagger}{d\theta} = \sigma_\phi^2 \frac{2\theta\sigma_f^2+\lambda\eta\sigma_f^2+\lambda\eta\sigma_x^2-\theta^2\lambda\eta\sigma_\phi^2}{\left(\sigma_f^2+\sigma_x^2+\theta^2\sigma_\phi^2\right)^2} \propto 2\theta\sigma_f^2+\lambda\eta\left(\sigma_f^2+\sigma_x^2-\theta^2\sigma_\phi^2\right)$.

Corollary 1 provides two results regarding potential impacts of ESG-relevant features (λ and θ) on price sensitivity to the financial report. These are operationalizable, as empirical measures of each are readily available. For instance, λ could be captured by the fraction of firm-, country-, or market-level funds that are signatories of the United Nations Principles for Responsible Investment (PRI). For θ, the recent Inflation Reduction Act (IRA) in the U.S. made several policy changes including subsidies and tax credits that increased the financial benefits to ESG-positive actions, i.e., increasing θ. Finally, the price sensitivity to the financial report has a clear empirical analogy in the oft-used earnings response coefficient obtained from regressing abnormal returns around an earnings announcement on a measure of the earnings innovation or surprise.

The intuition underlying Corollary 1 is as follows. The parameter θ determines the marginal impact of the manager's effort on both cash flows and the financial report. As a result, the correlation between the financial report and cash flows is always positive, and is increasing in the magnitude, $|\theta|$. Therefore, the financial report is a better reflection of cash flows for a higher value $|\theta|$. While type-1 investors are content to infer cash flows from the financial report (and, thus, always place a positive weight on the financial report), type-2 investors also care about the firm's ESG performance. Because effort affects the financial report and ESG performance differently, the effects of $|\theta|$ on type-2 investors' reactions can be nonmonotonic.

When $\theta > 0$ both type-1 and type-2 investors place a positive weight on the financial report. However, type-2 investors, relative to type-1 investors, place a larger positive weight on the report because they also care about the positively associated ESG performance. In turn, when $\theta < 0$, type-2 investors place a smaller weight on the financial report, because it is negatively correlated with the firm's ESG performance. For sufficiently negative values of

θ, type-2 investors may even place a negative weight on the report altogether. As a result, increasing the fraction of type-2 investors reduces the average weight on the report in price (Corollary 1, part 1).

In Corollary 1, part 2, we investigate changes in θ itself. For $\theta > 0$, type-1 investors monotonically increase the weight on the financial report as θ increases. Type-2 investors reduce the weight on the financial report once θ becomes sufficiently large because the correlation between the financial report and ESG performance increases in θ for $\theta < \eta$ but decreases in θ for $\theta > \eta$. For $\theta < 0$, type-1 investors reduce their weight on the report as θ becomes less negative. Because this reduces the negative correlation between the report and ESG performance, type-2 investors may increase their weight on the report, leading to the non-monotone result.

5 Environment with financial and ESG reports

We now present the equilibrium with both ESG and financial reports. ESG reports provide information about the firm's ESG effort, but they are not introduced into an information vacuum. Even with only financial reports, investors are able to make inferences and update their beliefs about the firm's ESG activities, e. As we will see below, the introduction of ESG reporting improves learning about mot only the ESG effort, but also the firm's non-ESG cash flow component, ε_x.

Lemma 2 *In equilibrium with ESG and financial reports without misreporting, the stock price and manager's effort are given by*

$$\begin{aligned} p^* &= E_x^* + \frac{\hat{\sigma}_x^2}{\sigma_f^2}\left(f - E_f^*\right) + \frac{\hat{\sigma}_{xy}}{\delta^2\sigma_r^2}\left(r - E_r^*\right) \\ &\quad +\lambda\left(E_y^* + \frac{\hat{\sigma}_{xy}}{\sigma_f^2}\left(f - E_f^*\right) + \frac{\hat{\sigma}_y^2}{\delta^2\sigma_r^2}\left(r - E_r^*\right)\right) \\ &\quad -\rho\hat{\sigma}_{x|f,r}^2 \ \textit{and} \\ e^* &= \phi + \frac{\varphi_r^*\eta + \varphi_f^*\theta}{c_e}, \end{aligned}$$

where $E_j = E[j]$ *are prior means,* $\varphi_f^* = \frac{\partial p^*}{\partial f}$ *and* $\varphi_r^* = \frac{\partial p^*}{\partial r}$ *are the price responses to the financial report and ESG report,* $\hat{\sigma}_x^2 = Var[x|r,f]$*,* $\hat{\sigma}_y^2 = Var[y|r,f]$*, and* $\hat{\sigma}_{xy} = Cov[x,y|r,f]$*. Detailed expressions for these are given in the Appendix.*

To explore the implications of a firm initiating ESG reporting for its price and financial and ESG performance, we compare the equilibria with and without ESG reporting (i.e., equilibria under Lemmas 1 and 2). We do not differentiate between voluntary and mandatory ESG reporting adoption per se, however, we develop results around expected pricing effects to illustrate when a price-maximizing manager would choose to adopt ESG reporting.[16]

Recall from the discussion above that introducing ESG reports has three primary effects. First, the ESG report provides additional information about the firm's ESG efforts, which are relevant to cash flows and ESG performance. Second, the ESG report changes what investors learn from the financial report, as they are both noisy signals of the firms' actions and performance. Third, these two effects conspire to change the market pricing of the manager's effort and reporting choices, which in turn change her equilibrium incentives and actions.

To facilitate discussion of the effects of adding an ESG report, we introduce the following notation. The change in the price response to the financial report is defined as $\Delta_\varphi = \varphi_f^* - \varphi_f^\dagger$. For brevity, we will refer to this as the change in the earnings response coefficient, or ERC. Similarly, the changes in expected cash flows and ESG performance are defined as $\Delta_x = x^* - x^\dagger$ and $\Delta_y = y^* - y^\dagger$. We also present results for changes in expected share ownership by type-1 and type-2 investors: $\Delta_{q_1} = E[q_1^*] - E\left[q_1^\dagger\right]$ and $\Delta_{q_2} = E[q_2^*] - E\left[q_2^\dagger\right]$. With this nomenclature in hand, we present our main results of this subsection in Propositions 1-3 below. Each proposition presents results for a range of θ.

Proposition 1 *When the cash flow effects of ESG effort are positive* ($\theta > 0$)*, the price response to the ESG report is positive* ($\varphi_r^* > 0$) *and introducing ESG reporting has the following effects:*

[16] Black et al. (2022) provide evidence that greater ESG concerns among a firm's investors are associated with increased ESG disclosures.

1. *the ERC decreases,* $\Delta_\varphi < 0$*;*
2. *expected cash flows and ESG performance both increase,* $\Delta_x, \Delta_y > 0$*; and*
3. *ESG-(dis)interested investors increase (decrease) their holdings,* $\Delta_{q_2} > 0 > \Delta_{q_1}$.

When the ESG effort has a positive cash-flow impact, the weight on the ESG report is positive because all investors interpret the ESG report as providing positive news. Given the alignment with the financial report, the response to the the financial report decreases. This fits with natural intuition in a multi-signal game: adding a positively correlated signal reduces the agents' (i.e., investors') reliance on existing signals. Even though investors react less positively to the financial report after ESG reporting is introduced, firm cash flows do not decrease, as the manager's incentives to engage in ESG efforts face a net increase from the joint impact of the ESG and financial reports. This increases ESG and financial performance, the latter driven by the positive effect of ESG efforts on cash flows. The increase in expected ESG performance in turn shifts the shareholder base in favor of investors who value ESG performance.

Proposition 2 *When the cash flow effects of ESG effort are moderately negative (*$0 \geq \theta \geq -\lambda\eta\left(\sigma_f^2 + \sigma_x^2\right)/\sigma_f^2$*), the price response to the ESG report is positive (*$\varphi_r^* \geq 0$*) and introducing ESG reporting has the following effects:*

1. *the ERC increases,* $\Delta_\varphi \geq 0$*; and*
2. *expected cash flows decrease while expected ESG performance increases,* $\Delta_x \leq 0 \leq \Delta_y$.

The inequalities in the predictions are strict when the inequalities in the condition are strict, i.e., when $0 > \theta > -\lambda\eta\left(\sigma_f^2 + \sigma_x^2\right)/\sigma_f^2$.

When the action has a moderately negative cash-flow impact, the weight on the ESG report is positive despite investors interpreting a more positive ESG report as bad news for cash flows. Essentially, the market response to the ESG report remains positive because the cash flow effects are not too negative given a sufficiently large fraction of ESG-interested investors (λ), a large effect of ESG efforts on ESG performance (η), and non-ESG cash flows that are important relative to financial reporting noise $\left(\left(\sigma_f^2 + \sigma_x^2\right)/\sigma_f^2\right)$. An important

conclusion is that a positive price response to ESG news is not always indicative of the relation between ESG efforts and cash flows. Even if cash flows decrease when a firm pursues ESG actions, the critical mass of ESG-interested investors in the market may lead to a positive price response.

Interestingly, the introduction of the ESG report in this region of the parameter space causes investors' response to the financial report to increase. This results from the ESG report effectively being a negative measure of expected cash flows. Investors giving the ESG report positive weight makes them increase their response to the financial report, which is a direct measure of cash flows.

Turning to the manager's effort, the net effect of adding the ESG report given $0 > \theta > -\lambda\eta\left(\sigma_f^2 + \sigma_x^2\right)/\sigma_f^2$ is to increase incentives to engage in ESG efforts. This increases ESG performance but, due to $\theta < 0$, decreases expected cash flows.

Whether the holdings by ESG investors increase or not depends on the magnitudes of the cash-ESG trade-off and investors' uncertainty about the manager's ESG preferences. Note that the change in shareholdings by ESG-interested investors is proportional to $\Phi = \sigma_x^2\left(\theta\sigma_f^2 + \lambda\eta\left(\sigma_f^2 + \sigma_x^2\right)\right) + \theta^2\sigma_f^2\sigma_\phi^2\left(\theta + \lambda\eta\right)$. The assumption of $\theta > -\lambda\eta\left(\sigma_f^2 + \sigma_x^2\right)/\sigma_f^2$ in Proposition 2 implies that the first term is positive. For $-\lambda\eta < \theta < 0$ the second term is positive, and ESG-interested investor holdings increase. For $\theta < -\lambda\eta < 0$ the second term is negative. In this situation, a sufficiently low value of σ_ϕ^2 ensures that $\Phi > 0$, whereas $\Phi < 0$ holds for sufficiently high values of σ_ϕ^2. Thus, in this region of the parameter space, we would expect ESG investors to increase their holdings when the manager's ESG efforts are relatively predictable, ex ante, while more uncertainty about the manager's efforts would cause the introduction of ESG reports to tilt the shareholder base towards traditional investors.

Proposition 3 *When the cash flow effects of ESG effort are sufficiently negative ($\theta < -\lambda\eta\left(\sigma_f^2 + \sigma_x^2\right)/\sigma_f^2$), the price response to the ESG report is negative ($\varphi_r^* < 0$) and introducing ESG reporting has the following effects:*

1. *the ERC decreases, $\Delta_\varphi < 0$;*

2. *expected cash flows increase while expected ESG performance decreases,* $\Delta_x > 0 > \Delta_y$*; and*

3. *ESG-interested investors decrease their holdings,* $\Delta_{q_2} < 0 < \Delta_{q_1}$.

When the ESG effort has a sufficiently negative cash-flow impact, the weight on the ESG report in the firm's price is negative. This occurs because investors' negative reaction to the ESG effort's cash flow effect outweighs the positive reaction by ESG-interested investors to the increased ESG output. In addition, because the ESG report, which is negatively correlated with the financial report, is now given a negative weight in the price, the price's response to the financial report decreases compared to the case without ESG reporting.

Because the firm's price puts a negative weight on the ESG report when ESG effort is very damaging to cash flows, the manager has weaker incentives to take ESG effort. As a result, ESG performance goes down and, because of the negative effect of ESG efforts on cash flows, expected cash flows increase.

Because the firm's ESG performance goes down, fewer shares are held by green investors. For firms with sufficiently negative cash flow effects of ESG efforts, the additional information about their ESG performance can discourage ESG efforts, improve expected cash flows, and tilt the shareholder base in favor of traditional type-1 investors. For these firms, introducing ESG reporting does not imply an increase in shares held by ESG-conscious investors.

Figure 1 illustrates the breakdown of the parameter space and results related to Propositions 1, 2, and 3. Whether the firm manager chooses to take a higher ESG effort after the introduction of ESG reporting depends on the extent of the cash flow-ESG trade-off that the firm faces as well as on the proportion of investors who value ESG performance. When there is no conflict between ESG and cash flows, i.e., the ESG effort increases cash flows (region (I)), the manager takes higher ESG effort after ESG reporting is introduced, increasing both ESG and cash flows. When the cash flow-ESG trade-off is not severe, the ESG effort moderately reduces cash flows (region (II)). Given that enough investors value ESG, the manager prioritizes ESG over cash flows and takes higher ESG effort, increasing

ESG and reducing cash flows. Finally, when the cash flow-ESG trade-off is substantial, i.e., the ESG effort is quite damaging for cash flows (region (III)), the manager prioritizes cash flows over ESG and reduces her ESG effort after ESG reporting is introduced.

The following proposition characterizes the expected change in price after the introduction of ESG reporting. A manager seeking to maximize expected price, for instance, would adopt ESG reporting when this quantity is positive.

Proposition 4 *Introducing ESG reporting yields an expected price change of*

$$\begin{aligned}\Delta_p &= E\left[p^*\right] - E\left[p^\dagger\right] \\ &= (\theta + \lambda\eta)\frac{\eta}{c_e}\varphi_r^* \qquad (2) \\ &\quad + (\theta + \lambda\eta)\frac{\theta}{c_e}\left(\varphi_f^* - \varphi_f^\dagger\right) \qquad (3) \\ &\quad + \rho\left(\sigma_{x|f}^2 - \hat{\sigma}_x^2\right).\end{aligned}$$

The expected price is affected by the introduction of ESG reporting in three ways. First, the price response to the ESG report provides incentives for the ESG effort. The firm's ESG effort changes by $\frac{\eta}{c_e}\varphi_r^*$, which is reflected in the price change as a change in expected cash flows, $\theta\frac{\eta}{c_e}\varphi_r^*$, and as a change in expected ESG performance multiplied by the fraction of investors caring about ESG $\lambda\eta\frac{\eta}{c_e}\varphi_r^*$. Second, the changed price response to the financial report also alters the manager's ESG effort. The shift is captured by $\frac{\theta}{c_e}\left(\varphi_f^* - \varphi_f^\dagger\right)$ and is capitalized into price in the same manner as the shift driven by the price response to the ESG report. Finally, since the ESG report provides additional information about the firm's cash flows, cash flow risk goes down, reducing the risk premium proportionally to investors' risk aversion parameter, ρ. The net impact of the three effects is not necessarily positive, given the variation in potential effects on response coefficients, φ_r and φ_f, the potential for cash flow effects of ESG efforts, θ, to be positive or negative, and the incremental effects of risk aversion that did not affect the results of Propositions 1, 2, and 3 above. The following corollary provides the condition under which the introduction of ESG reporting can be expected to reduce the firm's price.

Corollary 2 *Introducing ESG reporting reduces the expectation of firm price if and only if*

$$\rho < -\frac{\theta + \lambda\eta}{c_e \theta^2 \sigma_\phi^2} \left(\theta + \lambda\eta \left(1 + \frac{\sigma_x^2}{\sigma_f^2} \right) \right) \left(1 + \frac{\sigma_x^2}{\sigma_f^2} \right). \tag{4}$$

A necessary condition for the expected firm price to decrease is $-\lambda\eta \left(1 + \frac{\sigma_x^2}{\sigma_f^2}\right) < \theta < -\lambda\eta$.

Information provided by the ESG report about cash flows reduces the risk premium, increasing price. Corollary 2 shows that this effect needs to be sufficiently small (for example, because investors' risk aversion is sufficiently small) for price to decrease. Interestingly, expected price is more likely to decrease, i.e., will decrease for a larger range of ρ, when the financial report is more informative about the non-ESG cash flow variation (a high value of $\frac{\sigma_x^2}{\sigma_f^2}$ makes the region in the necessary condition larger). In this case, investors respond more positively to the ESG report because there is more to learn about the manager's effort, relative to what can be gleaned from the financial report. This motivates the manager to provide more effort, but with $\theta < 0$, this effort reduces cash flows. When the necessary condition at the end of Corollary 2 holds, the manager increases the ESG effort too much relative to investors' preferences. When ρ is high, this effect is more than offset by a lower risk premium, leading to a net positive effect on expected price. When ρ is low, however, the increase in cash-reducing ESG efforts dominates, yielding a net decrease in expected price. We plot the expected change in the firm's price, Δ_p, as a function of the cash flow impact of ESG, θ, for different levels of investors' risk-aversion, ρ, in Figure 3.

Condition (4) can also be interpreted or rearranged to highlight the importance of uncertainty about the manager's ESG preferences, σ_ϕ^2, or the cost of ESG effort, c_e. Introducing ESG reporting reduces firm price, in expectation, when the manager's ESG preferences are not very uncertain, or when the ESG effort is not too costly, as well as when investors have low risk aversion.

In effect, there are four regions for the parameter values that determine the effect of ESG reporting on price in lines (2) and (3) in Proposition 4, above. First, when the ESG effort also has a positive cash-flow effect, or $\theta > 0$, introducing the ESG report incentivizes

the manager to take a higher ESG effort, which increases both expected cash flows and expected ESG performance. Because of both positive cash flow and ESG outcomes, the firm's price increases. Second, when the ESG effort has a very mild negative effect on cash flows, or $0 > \theta > -\lambda\eta$, introducing the ESG report still incentivizes a higher ESG effort, which increases expected ESG performance but decreases cash flows. However, the reduction in cash flows is sufficiently small compared to the gain in ESG performance weighted by investor preferences, and, again, the firm's price increases. Third, when the ESG effort has a more pronounced negative but not too damaging cash flow impact, or $-\lambda\eta\left(1+\frac{\sigma_x^2}{\sigma_f^2}\right) < \theta < -\lambda\eta$ (as in Corollary 2), introducing the ESG report still increases the manager's ESG effort, increasing the expected ESG performance but hurting the expected cash flows. However, in this setting, the average investor does not benefit from an increase in effort and would prefer the manager to prioritize cash flows over ESG. Such a disconnect between the manager's price-driven incentives and an average investor's preferences implies the firm's price can decrease. Finally, for an ESG action that is very damaging to cash flows, or when $-\lambda\eta\left(1+\frac{\sigma_x^2}{\sigma_f^2}\right) < \theta$, introducing the ESG report reduces the effort incentives. This increases cash flows (because the manager reduces activities that benefit ESG performance at a sufficiently large cost to cash flows) but decreases the firm's ESG performance. This trade-off is valuable to the average investor and, thus, the firm's price increases.

Figure 2 illustrates the effects of introducing ESG reporting on prices, ESG performance, and financial performance. To facilitate empirical tests and interpretation, Table 1 summarizes predicted impacts of introducing ESG reporting on the ERC, the firm's price, cash flow and ESG performance, and investors' holdings.

The results in this section suggest a number of testable predictions. One particularly interesting prediction involves cross-sectional variation in the effects on stock prices, in expectation, around the introduction of mandatory ESG reporting. For many firms, we derive a positive effect on price, due to the additional information from the ESG report reducing risk premia and helping to align the manager's action with average shareholder preferences.

However, we predict a price drop under two conditions. First, the firm's ESG activities are moderately damaging to its cash flows. The second condition can be expressed with respect to several model parameters: the company's investors have low risk aversion (which may be descriptive for investors with high wealth or at certain life stages (Morin and Suarez (1983))); the manager's ESG preferences are clearer (e.g., if the manager is more established and known by the market); or the cost of the manager's ESG effort is not very high (for example, if the manager is indifferent across different ESG-related projects).

6 Implications for financial misreporting and greenwashing

Having considered the real and pricing implications of introducing ESG reporting, we next study the potential effects on the manager's misreporting behavior. To do so, we extend the model by allowing the manager to control the financial and ESG reports, which can be biased at a cost, after choosing e and observing ε_x, ε_f, and ε_r.

The manager's reporting cost of choosing the financial report, f, is $\frac{c_f}{2}(f - x - \varepsilon_f)^2$, with $c_f > 0$ and $\varepsilon_f \sim N\left(0, \sigma_f^2\right)$. As in Dye and Sridhar (2008), ε_f "reflects idiosyncratic circumstances that influence the manager's misreporting costs and prevents unraveling of the reporting bias effect in pricing," and could alternatively be incorporated via a mechanism as in Fischer and Verrecchia (2000) with uncertain incentives. Unlike pure window-dressing models, the manager does not minimize her reporting cost by issuing unbiased reports. Rather, her costs are minimized when she issues a report that incorporates true cash flows, $x = \theta e + \varepsilon_x$, as well as her idiosyncratic reporting circumstances, summarized by ε_f.

The cost to the manager of reporting ESG performance, r, is $\frac{c_r}{2}(r - \eta e - \delta\varepsilon_r)^2$. As with the financial report, the ESG report is affected by $\varepsilon_r \sim N(0, \sigma_r^2)$, which represents idiosyncratic circumstances that affect the manager's ESG reporting incentives. These could be reputational costs or benefits associated with greenwashing. To facilitate comparison with

results above, we retain ε_f and ε_r, but interpret them as reflecting idiosyncratic reporting motives known only to the manager. For investors, they continue to be sources of uncertainty in the mapping from financial and ESG reports into cash flows and ESG performance. Additionally, the commonly-known parameter $\delta > 0$ scales the importance of these idiosyncratic incentives. For instance, a greater penalty for greenwashing or requirements to audit the ESG report would be captured by a smaller δ.[17]

The manager's modified utility function is

$$u_m = p - \frac{c_e}{2}(e-\phi)^2 - \frac{c_f}{2}(f - x - \varepsilon_f)^2 - \frac{c_r}{2}(r - \eta e - \delta\varepsilon_r)^2. \tag{5}$$

Now at time $t = 1$, the manager observes the non-ESG cash flows, ε_x, and idiosyncratic reporting circumstances, ε_f and ε_r, and actively chooses financial and ESG reports r and f to be reported to investors.

The lemma below describes the equilibrium in the setting where the firm manager can manipulate financial and ESG reports.

Lemma 3 *In the equilibrium with ESG and financial misreporting, the stock price, manager's effort, financial report, and ESG report are given by*

$$\begin{aligned}
p^\ddagger &= E_x^\ddagger + \frac{\hat{\sigma}_x^2}{\sigma_f^2}\left(f - E_f^\ddagger\right) + \frac{\hat{\sigma}_{xy}}{\delta^2\sigma_r^2}\left(r - E_r^\ddagger\right) \\
&\quad + \lambda\left(E_y^\ddagger + \frac{\hat{\sigma}_{xy}}{\sigma_f^2}\left(f - E_f^\ddagger\right) + \frac{\hat{\sigma}_y^2}{\delta^2\sigma_r^2}\left(r - E_r^\ddagger\right)\right) \\
&\quad - \rho\hat{\sigma}_x^2, \\
e^\ddagger &= \phi + \frac{\varphi_r^\ddagger\eta + \varphi_f^\ddagger\theta}{c_e}, \\
f^\ddagger &= \frac{\varphi_f^\ddagger}{c_f} + \theta e^\ddagger + \varepsilon_x + \varepsilon_f, \text{ and} \\
r^\ddagger &= \frac{\varphi_r^\ddagger}{c_r} + \eta e^\ddagger + \delta\varepsilon_r,
\end{aligned}$$

[17] The quantity that matters for our analysis is $\delta\sigma_r^2$. We include δ to clearly parameterize the importance of ε_r in equation (5).

where $E_j = E[j]$ are prior means, $\varphi_f^{\ddagger} = \frac{\partial p^{\ddagger}}{\partial f} = \varphi_f^*$ and $\varphi_r^{\ddagger} = \frac{\partial p^{\ddagger}}{\partial r} = \varphi_r^*$ are the price responses to the financial report and ESG report, respectively, and conditional variances are denoted by $\hat{\sigma}_x^2 = Var[x|r,f]$, $\hat{\sigma}_y^2 = Var[y|r,f]$, and $\hat{\sigma}_{xy} = Cov[x,y|r,f]$. Detailed expressions for these are given in the Appendix.

When the manager can choose financial and ESG reports provided to investors, she chooses to bias them in equilibrium proportionally to the price responses to the financial and ESG reports, respectively (terms $\frac{\varphi_f^{\ddagger}}{c_f}$ and $\frac{\varphi_r^{\ddagger}}{c_r}$). Investors anticipate the biases and adjust for them in equilibrium. Because we retain ε_f and ε_r as parameters that affect reporting noise from investors' perspectives, the firm's price and the price responses to the ESG and financial reports do not change when misreporting is introduced. This is an expositional shortcut, not a prediction that, for instance, σ_r^2 would be the same whether it reflects exogenous reporting noise or idiosyncratic circumstances that influence the manager's biasing costs or incentives.

Importantly, the effect of price responses on financial and ESG misreporting is not the same as on the manager's ESG effort since when choosing her effort, the manager takes into account the effect of the ESG effort on cash flows and ESG performance, as they are reported. In particular, for the financial report, whether the manager takes a higher or lower effort in response to the higher price depends on the cash flow implications of the ESG effort $\left(\frac{\varphi_f^{\ddagger}\theta}{c_e}\right)$. If investors respond more to the financial report ($\varphi_f^{\ddagger}$ is higher) but the ESG effort damages cash flows ($\theta < 0$), the manager will choose a lower ESG effort. At the same time, the manager will always bias her financial report more in response to the increase in ERC (term $\frac{\varphi_f^{\ddagger}}{c_f}$). This implies that ESG effort and financial misreporting can go in the same or in different directions depending on whether the ESG activity is benefiting or hurting the firm's cash flows. Because financial misreporting is driven by the price response to the financial report, the four regions in Figure 2 also show the impact of introducing ESG reporting on financial misreporting. In particular, after the introduction of ESG reporting financial misreporting decreases in regions (I) and (III) but it increases in regions (IIa) and (IIb).

7 Marginal effects of investor preferences and of the cash-ESG trade-off

In this section, we consider how changes in the parameters describing investors' preferences and the cash-ESG trade-off in equilibrium affect ESG, cash flow, price, and reporting outcomes. These comparative statics provide testable empirical predictions, summarized in Table 2, and can help researchers interpret associations observed in the data. Below, we present results related to expected financial misreporting and greenwashing, defined as $E\left[f^{\ddagger} - x^{\ddagger}\right] = \varphi_f^{\ddagger}/c_f$ and $E\left[r^{\ddagger} - \eta e^{\ddagger}\right] = \varphi_r^{\ddagger}/c_r$, respectively.

7.1 Changes in investor preferences (λ)

Several business press articles and academic studies have noted the secular increase in investor concerns over ESG, as exemplified in the massive run-up in ESG-related assets under management, the surge in PRI signatories, and increases in survey respondents who indicate ESG-related preferences in the past two decades (e.g., Hong and Shore, 2022; Kim and Yoon, 2022; Pastor et al., 2021). More recently, corporations have faced an anti-ESG movement from some politicians and investors (Winston, 2023). Different jurisdictions or markets are likely to differ in the degree to which their investors display ESG concerns. The implications of such temporal and cross-sectional patterns are borne out in the following corollary.

Corollary 3 *An increase in the fraction of investors who value the firm's ESG performance, λ, leads to:*

1. *increases in the price response to the ESG report, expected ESG performance, and ESG misreporting, i.e., greenwashing* ($\frac{d\varphi_r^{\ddagger}}{d\lambda}, \frac{dE\left[y^{\ddagger}\right]}{d\lambda}, \frac{d\left(\varphi_r^{\ddagger}/c_r\right)}{d\lambda} > 0$)*; and*
2. *effects on the price response to the financial report, expected cash flows, and expected financial misreporting that have the same sign as the effect of ESG effort on cash flows* ($\frac{d\varphi_f^{\ddagger}}{d\lambda}, \frac{dE\left[x^{\ddagger}\right]}{d\lambda}, \frac{dE\left[f^{\ddagger}-x^{\ddagger}\right]}{d\lambda} \propto \theta$).

Generally, an increase in the fraction of investors who value the firm's ESG performance implies that ESG performance becomes more valuable, on average, to the firm's shareholders.

The market responds more strongly to the ESG report, which motivates more positive ESG efforts as well as additional ESG-related misreporting. The increase in ESG efforts translates into greater expected ESG performance.

For financial outcomes, the effect of an increase in the proportion of ESG-concerned investors depends on the effects of ESG efforts on cash flows, i.e., θ. When these effects are positive, i.e., $\theta > 0$, investors react more positively to the financial report, as a more positive financial report implies greater ESG efforts and greater expected ESG performance. This motivates additional financial misreporting, while complementing the effort-increasing effect of the increased responsiveness to the ESG report. In contrast, if $\theta < 0$, a higher financial report implies lower ESG efforts, which attenuates investors' response to the financial report (see, e.g., Hitzemann et al., 2023) and provides less motivation for financial misreporting. Additionally, $\theta < 0$ means that the increase in ESG efforts in equilibrium leads to lower cash flows in expectation.

7.2 Changes in cash flow implications of ESG efforts (θ)

The magnitude and direction of the cash-flow effects of ESG activities, θ can vary cross-sectionally with corporations' business models, production technologies, or pro-ESG policies such as subsidies or taxes.[18] Corollary 1 shows (absent the ESG report) that the response coefficient on the financial report can increase or decrease when θ increases because investors use the report to update on two output dimensions. This intuition also applies with two reports: the price sensitivity to either report can increase or decrease in θ.

When $\theta > 0$, a further increase in the cash flow implications of ESG efforts increases both expected cash flows and expected ESG performance. In this situation, updating on both dimensions of the firm's output goes hand-in-hand. As the financial report becomes more informative about the firm's ESG efforts, the manager has incentives to increase these efforts and, thus, to increase the firm's outputs. However, while cash flow and ESG performance

[18] See, for example, a note by KPMG "Incorporating an ESG lens in business valuations" on how corporations could estimate cash flow implications of their ESG activities.

increase, the manager's misreporting in both reports can either increase or decrease. We denote $S = \left(1 + \frac{\eta^2\sigma_\phi^2}{\delta^2\sigma_r^2}\right)$ and use it to summarize these comparative statics.

Corollary 4 *When the firm provides both reports*

1. *expected cash flows and expected ESG performance increase in* θ *when* $\theta > 0$.
2. *expected financial misreporting increases (decreases) in* θ *when* $2S\theta\sigma_f^2 + \lambda\eta\left(S\left(\sigma_f^2 + \sigma_x^2\right) - \theta^2\sigma_\phi^2\right)$ *is positive (negative);*
3. *expected greenwashing increases (decreases) in* θ *when* $\sigma_f^2\left(S\left(\sigma_f^2 + \sigma_x^2\right) - \theta^2\sigma_\phi^2\right) - 2\theta\lambda\eta\sigma_\phi^2\left(\sigma_f^2 + \sigma_x^2\right)$ *is positive (negative),*

where $S = \left(1 + \frac{\eta^2\sigma_\phi^2}{\delta^2\sigma_r^2}\right)\left(\sigma_f^2 + \sigma_x^2\right)$.

Corollary 4 shows that output and misreporting of both financial and ESG performance are complements (all increase in θ) when θ is moderately positive, whereas they are substitutes (outputs increase in θ and misreporting decreases) when θ is sufficiently positive. Note that a larger fraction of type-2 investors (or a bigger impact of the efforts on the expected ESG performance) increases the parameter region for which output and misreporting are substitutes.

When ESG efforts have negative cash flow implications, an increase in θ is associated with a smaller signal-to-noise ratio in the financial report. That is, as a negative θ becomes less negative, less of the variation in the financial reports comes from the manager's effort choice, and investors glean less information about the effort-related outputs. This tends to reduce the effort incentives, which increases (decreases) expected cash flows (expected ESG performance) when the expected effort is positive and has the opposite effect when the expected effort is negative. Financial misreporting and greenwashing decrease in θ when θ is sufficiently negative (note the negative coefficient on θ^2 in both comparative static results) but both increase in θ when it is sufficiently close to zero.

7.3 Changes in idiosyncratic ESG reporting incentives (σ_r^2 or δ)

In our final set of comparative statics, we investigate a change in the informativeness of the ESG report, which can vary, for example, with the regulatory environment a corporation operates in.[19] In particular, when either σ_r^2 or δ increase, the amount of noise in the ESG report increases, and, thus, the report becomes less informative to investors.

Because green investors and type-1 investors infer different information from the ESG report, the signs of the comparative statics depend on the correlation between cash flows and ESG performance, θ. The following corollary summarizes the results.

Corollary 5 *When the firm provides both reports, increasing δ or σ_r^2 has the following effects.*

1. *When the cash flow effects of ESG effort are positive ($\theta > 0$)*
   (a) *the price response to the financial (ESG) report increases (decreases); and*
   (b) *expected cash flows, ESG performance, and greenwashing decrease while expected financial misreporting increases;*
2. *when the cash flow effects of ESG effort are moderately negative ($0 > \theta > -\lambda\eta\left(\sigma_f^2 + \sigma_x^2\right)/\sigma_f^2$)*
   (a) *the price responses to the financial and ESG reports decrease; and*
   (b) *expected cash flows increase, while expected ESG performance, financial misreporting, and greenwashing decrease; and*
3. *when the cash flow effects of ESG effort are sufficiently negative ($\theta < -\lambda\eta\left(\sigma_f^2 + \sigma_x^2\right)/\sigma_f^2$)*
   (a) *the price responses to the financial and ESG reports increase; and*
   (b) *expected cash flows decrease, while expected ESG performance, financial misreporting, and greenwashing increase.*

For all parameter values, expected ESG performance and expected greenwashing are complements. That is, increases in greenwashing go hand-in-hand with increases in ESG performance. However, expected cash flows and financial misreporting are substitutes: when cash flows decrease, the manager increases the extent of financial misreporting.

[19] For a review of greenwashing regulations around the world, see Sustainalytics' publication, "Global Greenwashing Regulations: How the World Is Cracking Down on Misleading Sustainability Claims".

Similar to our results in Propositions (1-3), when $\theta > 0$, green investors and traditional investors both value an increase in the manager's effort. In this situation, an increase in the noise of the ESG signal reduces the weight on that signal and increases the weight on the financial report. As a result, increasing the noise in the ESG report leads to more financial misreporting but less greenwashing. Because price responds more weakly to the manager's effort, this effort is reduced and both types of output suffer.

In turn, when θ is moderately negative ($0 > \theta > -\lambda\eta\left(\sigma_f^2 + \sigma_x^2\right)/\sigma_f^2$), green investors place a positive weight on the ESG report (the manager's effort increases the output to type-2 investors) whereas traditional investors place a negative weight on it (the manager's effort lowers the output to type-1 investors). Because the negative cash flow impact is relatively small, the aggregate weight remains positive. An increase in the noise in the ESG report reduces the price response to the ESG report (as before). However, in this parameter region the weight on the financial report also decreases. The reason is green investors' learning about the ESG activities. When the ESG report becomes less informative, type-2 investors place a more negative weight on the financial report (because the financial report is negatively correlated with the output that type-2 investors care about).[20] The lower aggregate weight on the financial report leads to lower incentives for financial misreporting.

Finally, when θ is sufficiently negative ($\theta < -\lambda\eta\left(\sigma_f^2 + \sigma_x^2\right)/\sigma_f^2$), the average investor places a negative weight on the ESG report. That is, for investors in aggregate, the increase in ESG performance that a high ESG report signals is not worth the cost to cash flows. For these parameter values, the manager has negative greenwashing (i.e., brownwashing) incentives, which signal higher cash flows. Decreasing the informativeness of the ESG report dampens these incentives. As a result, the expected ESG performance increases and the expected greenwashing becomes less negative when the ESG report becomes noisier. Table 2 summarizes the comparative statics results.

[20]Note that in this parameter region, type-1 investors increase their weight on the financial report when δ or σ_r^2 increase. However, the lower weight that type-2 investors put on the financial report dominates, such that the aggregate weight decreases.

8 Conclusion

In response to growing interest in ESG reporting, we develop a framework for considering the effects of introducing ESG reports to a capital market setting featuring existing financial reporting. We show how introducing the ESG report affects the manager's ESG effort incentives, prices, reporting strategies, and investor holdings. When the ESG effort has a positive (sufficiently negative) impact on the firm's cash flows, introducing the ESG report increases prices and cash flows by increasing (decreasing) the manager's effort incentives. However, when the effort has a moderately negative impact on cash flows, ESG reporting can increase the incentives to reduce cash flows and, in turn, reduce the firm's price. In the equilibrium with both reports, we derive conditions under which firms with lower expected ESG performance have higher greenwashing incentives, but we also show that incentives to increase ESG performance can go hand-in-hand with greenwashing incentives. That is, ESG improvement and greenwashing can be complements or substitutes.

Overall, our paper contributes to the emerging literature on ESG reporting, providing a framework for developing and interpreting empirical results in a capital market setting. We view welfare implications and contracting as important but outside the scope of our endeavor. Considering these is likely to result in additional interesting implications of the expansion of ESG reporting and the secular increase in investors' interests in firms' ESG performance but requires care around the specification of regulatory and welfare objectives.

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Appendix

Proof of Lemmas 1 and 2 and Corollary 1

We solve the model with managerial control over both reports (Lemma 3) via backward induction then derive the equilibria in Lemmas 1 and 2 as a special cases.

Given the CARA-normal setting, share demands are given by $q_1 = \frac{E[x|r,f]-p}{\rho Var[x|r,f]}$ and $q_2 = \frac{E[x+y|r,f]-p}{\rho Var[x|r,f]}$. Substituting demands into the market clearing condition $1 = \lambda q_2 + (1-\lambda) q_1$ gives the price function as

$$\begin{aligned} 1 &= \lambda \frac{E[x+y|r,f]-p}{\rho Var[x|r,f]} + (1-\lambda)\frac{E[x|r,f]-p}{\rho Var[x|r,f]} \\ \Leftrightarrow p &= E[x|r,f] + \lambda E[y|r,f] - \rho Var[x|r,f]. \end{aligned} \tag{6}$$

Joint normality implies

$$Var\begin{bmatrix} x \\ y \\ r \\ f \end{bmatrix} = \begin{bmatrix} \sigma_x^2+\theta^2\sigma_\phi^2 & \theta\eta\sigma_\phi^2 & \theta z\sigma_\phi^2 & \sigma_x^2+\theta^2\sigma_\phi^2 \\ \theta\eta\sigma_\phi^2 & \eta^2\sigma_\phi^2 & \eta^2\sigma_\phi^2 & \theta\eta\sigma_\phi^2 \\ \theta\eta\sigma_\phi^2 & \eta^2\sigma_\phi^2 & \eta^2\sigma_\phi^2+\delta^2\sigma_r^2 & \theta\eta\sigma_\phi^2 \\ \sigma_x^2+\theta^2\sigma_\phi^2 & \theta\eta\sigma_\phi^2 & \theta\eta\sigma_\phi^2 & \sigma_x^2+\theta^2\sigma_\phi^2+\sigma_f^2 \end{bmatrix}$$

such that

$$\begin{aligned} Var\begin{bmatrix} \tilde{x} \\ \tilde{y} \end{bmatrix} \Big| r,f \Bigg] &= \begin{bmatrix} \sigma_x^2+\theta^2\sigma_\phi^2 & \theta\eta\sigma_\phi^2 \\ \theta\eta\sigma_\phi^2 & \eta^2\sigma_\phi^2 \end{bmatrix} \\ &\quad - \begin{bmatrix} \theta\eta\sigma_\phi^2 & \sigma_x^2+\theta^2\sigma_\phi^2 \\ \eta^2\sigma_\phi^2 & \theta\eta\sigma_\phi^2 \end{bmatrix} \begin{bmatrix} \eta^2\sigma_\phi^2+\delta^2\sigma_r^2 & \theta\eta\sigma_\phi^2 \\ \theta\eta\sigma_\phi^2 & \sigma_x^2+\theta^2\sigma_\phi^2+\sigma_f^2 \end{bmatrix}^{-1} \begin{bmatrix} \theta\eta\sigma_\phi^2 & \eta^2\sigma_\phi^2 \\ \sigma_x^2+\theta^2\sigma_\phi^2 & \theta\eta\sigma_\phi^2 \end{bmatrix}. \end{aligned}$$

Conditional variances can be rewritten as

$$\begin{aligned}
Var\left[x|r,f\right] &= \hat{\sigma}_x^2 = \sigma_{x|r,f}^2 = \sigma_f^2 \frac{\left(1+\frac{\eta^2}{\delta^2\sigma_r^2}\sigma_\phi^2\right)\sigma_x^2 + \theta^2\sigma_\phi^2}{\left(1+\frac{\eta^2}{\delta^2\sigma_r^2}\sigma_\phi^2\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2}, \\
Var\left[y|r,f\right] &= \hat{\sigma}_y^2 = \sigma_{y|r,f}^2 = \eta^2\sigma_\phi^2 \frac{\sigma_f^2+\sigma_x^2}{\left(1+\frac{\eta^2}{\delta^2\sigma_r^2}\sigma_\phi^2\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2}, \text{ and} \\
Cov\left[x,y|r,f\right] &= \hat{\sigma}_{xy} = \sigma_{xy|r,f} = \theta\eta\sigma_f^2 \frac{\sigma_\phi^2}{\left(1+\frac{\eta^2}{\delta^2\sigma_r^2}\sigma_\phi^2\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2}.
\end{aligned}$$

Conditional means are given by

$$E\left[\begin{matrix}\tilde{x}\\ \tilde{y}\end{matrix}\middle| r,f\right] = \begin{bmatrix}E_x\\ E_y\end{bmatrix} + \begin{bmatrix}\theta\eta\sigma_\phi^2\sigma_x^2+\theta^2\sigma_\phi^2 \\ \eta^2\sigma_\phi^2\eta\theta\sigma_\phi^2\end{bmatrix}\begin{bmatrix}\eta^2\sigma_\phi^2+\delta^2\sigma_r^2\theta\eta\sigma_\phi^2 \\ \theta\eta\sigma_\phi^2\sigma_x^2+\theta^2\sigma_\phi^2+\sigma_f^2\end{bmatrix}$$

where E_x and E_y are prior expectations. Exploiting the expressions above for conditional variances and covariances, we have

$$\begin{aligned}
E\left[x|r,f\right] &= E_x + \frac{\left(\sigma_x^2\left(1+\frac{\eta^2}{\delta^2\sigma_r^2}\sigma_\phi^2\right)+\theta^2\sigma_\phi^2\right)(f-E_f)}{\left(\sigma_f^2+\sigma_x^2\right)\left(1+\frac{\eta^2}{\delta^2\sigma_r^2}\sigma_\phi^2\right)+\theta^2\sigma_\phi^2} \\
&\quad + \frac{\theta\left(\frac{\eta}{\delta^2\sigma_r^2}\sigma_f^2\sigma_\phi^2\right)(r-E_r)}{\left(\sigma_f^2+\sigma_x^2\right)\left(1+\frac{\eta^2}{\delta^2\sigma_r^2}\sigma_\phi^2\right)+\theta^2\sigma_\phi^2} \\
&= E_x + \frac{\hat{\sigma}_x^2}{\sigma_f^2}(f-E_f) + \frac{\hat{\sigma}_{xy}}{\delta^2\sigma_r^2}(r-E_r)
\end{aligned}$$

and

$$\begin{aligned}
E\left[y|r,f\right] &= E_y + \frac{\theta\eta\sigma_\phi^2(f-E_f)}{\left(\sigma_f^2+\sigma_x^2\right)\left(1+\frac{\eta^2}{\delta^2\sigma_r^2}\sigma_\phi^2\right)+\theta^2\sigma_\phi^2} \\
&\quad + \frac{\frac{\eta}{\delta^2\sigma_r^2}\eta\sigma_\phi^2\left(\sigma_f^2+\sigma_x^2\right)(r-E_r)}{\left(\sigma_f^2+\sigma_x^2\right)\left(1+\frac{\eta^2}{\delta^2\sigma_r^2}\sigma_\phi^2\right)+\theta^2\sigma_\phi^2} \\
&= E_y + \frac{\hat{\sigma}_{xy}}{\sigma_f^2}(f-E_f) + \frac{\hat{\sigma}_y^2}{\delta^2\sigma_r^2}(r-E_r).
\end{aligned}$$

Substituting these into equation (6) yields the price in Lemma 2. The price responses to the reports are given by

$$\begin{aligned}
\frac{\partial p^*}{\partial f} &= \varphi_f^* = \frac{\hat{\sigma}_x^2}{\sigma_f^2} + \lambda \frac{\hat{\sigma}_{xy}}{\sigma_f^2} \\
&= \frac{\left(1 + \frac{\eta^2}{\delta^2 \sigma_r^2} \sigma_\phi^2\right) \sigma_x^2 + \theta^2 \sigma_\phi^2}{\left(1 + \frac{\eta^2}{\delta^2 \sigma_r^2} \sigma_\phi^2\right) \left(\sigma_f^2 + \sigma_x^2\right) + \theta^2 \sigma_\phi^2} + \lambda \theta \eta \frac{\sigma_\phi^2}{\left(1 + \frac{\eta^2}{\delta^2 \sigma_r^2} \sigma_\phi^2\right) \left(\sigma_f^2 + \sigma_x^2\right) + \theta^2 \sigma_\phi^2} \text{ and} \\
\frac{\partial p^*}{\partial r} &= \varphi_r^* = \frac{\hat{\sigma}_{xy}}{\delta^2 \sigma_r^2} + \lambda \frac{\hat{\sigma}_y^2}{\delta^2 \sigma_r^2} \\
&= \frac{\eta \theta \sigma_\phi^2}{\delta^2 \sigma_r^2} \frac{\sigma_f^2}{\left(1 + \frac{\eta^2}{\delta^2 \sigma_r^2} \sigma_\phi^2\right) \left(\sigma_f^2 + \sigma_x^2\right) + \theta^2 \sigma_\phi^2} + \lambda \frac{\eta^2 \sigma_\phi^2}{\delta^2 \sigma_r^2} \frac{\sigma_f^2 + \sigma_x^2}{\left(1 + \frac{\eta^2}{\delta^2 \sigma_r^2} \sigma_\phi^2\right) \left(\sigma_f^2 + \sigma_x^2\right) + \theta^2 \sigma_\phi^2}
\end{aligned}$$

Equilibrium reporting strategies, f^* and r^*, can be derived from substituting the price into the manager's utility (equation 5), and maximizing with respect to f and r, taking e, ϕ, ε_x, ε_f, and ε_r as given or known. Substituting these in addition into the manager's utility and maximizing with respect to the ESG effort, e, yields e^*. With this, equilibrium cash flows and ESG performance are $x^* = \theta e^* + \varepsilon_x$ and $y^* = \eta e^*$. Prior means, E_j^*, $j \in \{x, y, r, f\}$, can be derived by substituting in equilibrium efforts and reports and taking expectations.

Lemma 2 follows from setting $\delta = 1$ and letting $c_r, c_f \to \infty$. Lemma 1 can be derived by also letting $\sigma_r^2 \to \infty$. Corollary 1 follows from straightforward differentiation of equilibrium expressions in Lemma 1.

Proof of Propositions 1, 2, and 3

Denote $S_r = \delta^2\sigma_r^2$ and recall from Lemma 1 that $\phi_f^\dagger = \frac{\partial p^\dagger}{\partial f} = \frac{\sigma_x^2+\sigma_\phi^2\left(\theta^2+\lambda\theta\eta\right)}{\sigma_f^2+\sigma_x^2+\theta^2\sigma_\phi^2}$ is the ERC before the ESG report is introduced.

$$\begin{aligned}
\Delta_\varphi &= \varphi_f^* - \varphi_f^\dagger \\
&= \left(\frac{\left(1+\frac{\eta^2}{S_r}\sigma_\phi^2\right)\sigma_x^2+\theta^2\sigma_\phi^2}{\left(1+\frac{\eta^2}{S_r}\sigma_\phi^2\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2} + \lambda\theta\eta\frac{\sigma_\phi^2}{\left(1+\frac{\eta^2}{S_r}\sigma_\phi^2\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2}\right) - \frac{\sigma_x^2+\sigma_\phi^2\left(\theta^2+\lambda\theta\eta\right)}{\sigma_f^2+\sigma_x^2+\theta^2\sigma_\phi^2} \\
&= \frac{\frac{\eta^2}{S_r}\sigma_\phi^2\sigma_x^2}{\left(1+\frac{\eta^2}{S_r}\sigma_\phi^2\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2} \\
&\quad - \left(\sigma_x^2+\sigma_\phi^2\theta^2+\lambda\theta\eta\sigma_\phi^2\right)\left(\frac{1}{\sigma_f^2+\sigma_x^2+\theta^2\sigma_\phi^2} - \frac{1}{\left(1+\frac{\eta^2}{S_r}\sigma_\phi^2\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2}\right) \\
&= \frac{\frac{\eta^2}{S_r}\sigma_\phi^2\sigma_x^2}{\left(1+\frac{\eta^2}{S_r}\sigma_\phi^2\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2} \\
&\quad - \left(\sigma_x^2+\sigma_\phi^2\theta^2+\lambda\theta\eta\sigma_\phi^2\right)\frac{\sigma_\phi^2\frac{\eta^2}{S_r}\left(\sigma_f^2+\sigma_x^2\right)}{\left(\left(1+\frac{\eta^2}{S_r}\sigma_\phi^2\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2\right)\left(\sigma_f^2+\sigma_x^2+\theta^2\sigma_\phi^2\right)} \\
&= -\theta\sigma_\phi^2 * \frac{\theta\sigma_f^2+\lambda\eta\sigma_f^2+\lambda\eta\sigma_x^2}{\sigma_f^2+\sigma_x^2+\theta^2\sigma_\phi^2} * \frac{\frac{\eta^2}{S_r}\sigma_\phi^2}{\left(1+\frac{\eta^2}{S_r}\sigma_\phi^2\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2}.
\end{aligned}$$

Thus the sign of Δ_φ is the same as the sign of $-\theta\left(\theta\sigma_f^2+\lambda\eta\sigma_f^2+\lambda\eta\sigma_x^2\right)$. When $\theta > 0$, $-\theta\left(\theta\sigma_f^2+\lambda\eta\sigma_f^2+\lambda\eta\sigma_x^2\right) < 0 \Rightarrow \Delta_\varphi < 0$.

When $\theta < 0$,

$$\begin{aligned}
-\theta\left(\theta\sigma_f^2+\lambda\eta\sigma_f^2+\lambda\eta\sigma_x^2\right) > 0 &\iff \theta\sigma_f^2+\lambda\eta\sigma_f^2+\lambda\eta\sigma_x^2 > 0 \\
&\iff \theta > -\lambda\eta\left(1+\frac{\sigma_x^2}{\sigma_f^2}\right)
\end{aligned}$$

The change in financial misreporting is $\Delta_b = \frac{\varphi_f^*}{c_f} - \frac{\varphi_f^\dagger}{c_f} = \frac{\Delta_\varphi}{c_f}$. Thus, financial misreporting increases (decreases) whenever the ERC increases (decreases).

The cash flow when only financial report is issued is $x^{\dagger} = \theta\left(\phi + \frac{\varphi_f^{\dagger}\theta}{c_e}\right) + \varepsilon_x$, and when both reports are issued is $x^{*} = \theta\left(\phi + \frac{\varphi_r^{*}\eta + \varphi_f^{*}\theta}{c_e}\right) + \varepsilon_x$. The change in expected cash flows is

$$\begin{aligned}
\Delta_x = E[x^{*} - x^{\dagger}] &= (\theta e_x^{*}) - \theta\left(\phi + \frac{\varphi_f^{\dagger}\theta}{c_e}\right) \\
&= \frac{\theta}{c_e}\left(\begin{array}{c} \left(1 - \frac{\sigma_f^2}{\left(1+\frac{\eta^2\sigma_\phi^2}{\delta^2\sigma_r^2}\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2}\right) \\ + \left(1 - \frac{\sigma_f^2+\sigma_x^2}{\left(1+\frac{\eta^2\sigma_\phi^2}{\delta^2\sigma_r^2}\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2}\right)\lambda\eta - \frac{\sigma_x^2+\sigma_\phi^2\left(\theta^2+\lambda\theta\eta\right)}{\sigma_f^2+\sigma_x^2+\theta^2\sigma_\phi^2}\theta \end{array}\right) \\
&= \frac{\theta}{c_e}\frac{\eta^2\sigma_\phi^2}{\delta^2\sigma_r^2}\frac{\left(\sigma_f^2+\sigma_x^2\right)\left(\theta\sigma_f^2 + \lambda\eta\left(\sigma_f^2+\sigma_x^2\right)\right)}{\left(\sigma_f^2+\sigma_x^2+\theta^2\sigma_\phi^2\right)\left(\left(1+\frac{\eta^2\sigma_\phi^2}{\delta^2\sigma_r^2}\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2\right)},
\end{aligned}$$

such that Δ_x has the same sign as $\theta\left(\theta\sigma_f^2 + \lambda\eta\left(\sigma_f^2+\sigma_x^2\right)\right)$. Thus, $\theta > 0 \Rightarrow \Delta_x > 0$. Furthermore,

$$\begin{aligned}
\theta\left(\theta\sigma_f^2 + \lambda\eta\left(\sigma_f^2+\sigma_x^2\right)\right) > 0 &\iff \theta\sigma_f^2 + \lambda\eta\left(\sigma_f^2+\sigma_x^2\right) < 0 \\
&\iff \theta < -\lambda\eta\left(1 + \frac{\sigma_x^2}{\sigma_f^2}\right).
\end{aligned}$$

Expected ESG performance with only the financial report is $y^{\dagger} = \eta\left(\phi + \frac{\varphi_f^{\dagger}\theta}{c_e}\right)$, and with

both reports is $y^* = \eta\left(\phi + \frac{\varphi_r^*\eta + \varphi_f^*\theta}{c_e}\right)$. The change in expected ESG performance is

$$\begin{aligned}
\Delta_y = y^* - y^\dagger &= \eta e^* - \eta\left(\phi + \frac{\varphi_f^\dagger\theta}{c_e}\right) \\
&= \frac{\eta}{c_e}\left(\begin{array}{c}\left(1 - \frac{\sigma_f^2}{\left(1+\frac{\eta^2\sigma_\phi^2}{\delta^2\sigma_r^2}\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2}\right)\theta \\ + \left(1 - \frac{\sigma_f^2+\sigma_x^2}{\left(1+\frac{\eta^2\sigma_\phi^2}{\delta^2\sigma_r^2}\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2}\right)\lambda\eta - \frac{\sigma_x^2+\sigma_\phi^2\left(\theta^2+\lambda\theta\eta\right)}{\sigma_f^2+\sigma_x^2+\theta^2\sigma_\phi^2}\theta\end{array}\right) \\
&= \frac{\eta}{c_e}\frac{\eta^2\sigma_\phi^2}{\delta^2\sigma_r^2}\left(\sigma_f^2+\sigma_x^2\right)\frac{\theta\sigma_f^2 + \lambda\eta\left(\sigma_f^2+\sigma_x^2\right)}{\left(\sigma_f^2+\sigma_x^2+\theta^2\sigma_\phi^2\right)\left(\left(1+\frac{\eta^2\sigma_\phi^2}{\delta^2\sigma_r^2}\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2\right)},
\end{aligned}$$

such that the sign of Δ_y is the same as the sign of $\theta\sigma_f^2 + \lambda\eta\left(\sigma_f^2+\sigma_x^2\right)$. Thus, $\theta > 0 \Rightarrow \Delta_y > 0$ and

$$\theta\sigma_f^2 + \lambda\eta\left(\sigma_f^2+\sigma_x^2\right) > 0 \iff \theta > -\lambda\eta\left(1 + \frac{\sigma_x^2}{\sigma_f^2}\right)$$

Holdings of type-1 and type-2 investors, respectively, with only the financial report are

$$\begin{aligned}
E\left[q_1^\dagger\right] &= 1 - \lambda\frac{\theta\eta}{\rho\sigma_f^2 c_e}\left(1 + \frac{\theta\lambda\eta\sigma_\phi^2}{\sigma_x^2+\theta^2\sigma_\phi^2}\right) \text{ and} \\
E\left[q_2^\dagger\right] &= 1 + (1-\lambda)\,\theta\eta\frac{\sigma_x^2+\theta^2\sigma_\phi^2+\theta\lambda\eta\sigma_\phi^2}{\rho\sigma_f^2 c_e\left(\sigma_x^2+\theta^2\sigma_\phi^2\right)}.
\end{aligned}$$

With both reports, they are

$$\begin{aligned}
E\left[q_1^*\right] &= 1 - \lambda\frac{\eta}{\rho\sigma_f^2 c_e}\frac{Q\sigma_\phi^2\left(\sigma_f^2+\sigma_x^2\right)(\theta+\lambda\eta) + \theta\left(\sigma_x^2+\theta^2\sigma_\phi^2+\theta\lambda\eta\sigma_\phi^2\right)}{\sigma_x^2+\theta^2\sigma_\phi^2+Q\sigma_x^2\sigma_\phi^2} \text{ and} \\
E\left[q_2^*\right] &= 1 + (1-\lambda)\frac{\eta}{\rho\sigma_f^2 c_e}\frac{Q\sigma_\phi^2\left(\sigma_f^2+\sigma_x^2\right)(\theta+\lambda\eta) + \theta\left(\sigma_x^2+\theta^2\sigma_\phi^2+\theta\lambda\eta\sigma_\phi^2\right)}{\sigma_x^2+\theta^2\sigma_\phi^2+Q\sigma_x^2\sigma_\phi^2}.
\end{aligned}$$

where $Q = \frac{\eta^2}{\delta^2 \sigma_r^2}$. Thus, the changes in holdings are given by

$$\begin{aligned}
\Delta_{q1} &= E\left[q_1^*\right] - E\left[q_1^\dagger\right] \\
&= \lambda \frac{\eta}{\rho \sigma_f^2 c_e} \left(\theta \left(1 + \frac{\theta \lambda \eta \sigma_\phi^2}{\sigma_x^2 + \theta^2 \sigma_\phi^2} \right) - \frac{Q \sigma_\phi^2 \left(\sigma_f^2 + \sigma_x^2\right)(\theta + \lambda\eta) + \theta\left(\sigma_x^2 + \theta^2 \sigma_\phi^2 + \theta\lambda\eta\sigma_\phi^2\right)}{\sigma_x^2 + \theta^2\sigma_\phi^2 + Q\sigma_x^2\sigma_\phi^2} \right) \\
&= -\lambda \frac{\eta}{\rho \sigma_f^2 c_e} Q \sigma_\phi^2 \frac{\lambda\eta\sigma_x^4 + \lambda\eta\sigma_f^2\sigma_x^2 + \theta^2\lambda\eta\sigma_f^2\sigma_\phi^2 + \theta\sigma_f^2\sigma_x^2 + \theta^3\sigma_f^2\sigma_\phi^2}{\left(\sigma_x^2 + \theta^2\sigma_\phi^2\right)\left(\sigma_x^2 + \theta^2\sigma_\phi^2 + Q\sigma_x^2\sigma_\phi^2\right)} \text{ and} \\
\Delta_{q2} &= E\left[q_2^*\right] - E\left[q_2^\dagger\right] \\
&= (1-\lambda) \frac{\eta}{\rho \sigma_f^2 c_e} \left(\frac{Q \sigma_\phi^2 \left(\sigma_f^2 + \sigma_x^2\right)(\theta + \lambda\eta) + \theta\left(\sigma_x^2 + \theta^2 \sigma_\phi^2 + \theta\lambda\eta\sigma_\phi^2\right)}{\sigma_x^2 + \theta^2\sigma_\phi^2 + Q\sigma_x^2\sigma_\phi^2} - \theta\left(1 + \frac{\theta\lambda\eta\sigma_\phi^2}{\sigma_x^2 + \theta^2\sigma_\phi^2}\right) \right) \\
&= \lambda \frac{\eta}{\rho \sigma_f^2 c_e} Q \sigma_\phi^2 \frac{\lambda\eta\sigma_x^4 + \lambda\eta\sigma_f^2\sigma_x^2 + \theta^2\lambda\eta\sigma_f^2\sigma_\phi^2 + \theta\sigma_f^2\sigma_x^2 + \theta^3\sigma_f^2\sigma_\phi^2}{\left(\sigma_x^2 + \theta^2\sigma_\phi^2\right)\left(\sigma_x^2 + \theta^2\sigma_\phi^2 + Q\sigma_x^2\sigma_\phi^2\right)}.
\end{aligned}$$

Therefore, when $\theta > 0$, $\Delta_{q2} > 0$ and $\Delta_{q1} < 0$. We can express Δ_{q2} as:

$$\Delta_{q2} = \lambda \frac{\eta}{\rho \sigma_f^2 c_e} Q \sigma_\phi^2 \frac{\sigma_x^2\left(\theta\sigma_f^2 + \lambda\eta\left(\sigma_f^2 + \sigma_x^2\right)\right) + \theta^2\sigma_f^2\sigma_\phi^2(\theta + \lambda\eta)}{\left(\sigma_x^2 + \theta^2\sigma_\phi^2\right)\left(\sigma_x^2 + \theta^2\sigma_\phi^2 + Q\sigma_x^2\sigma_\phi^2\right)}$$

From here, we can see that $\varphi_r^* < 0$ implies that $\Delta_{q2} < 0$. The reason is that

$$\begin{aligned}
\varphi_r^* < 0 \quad &\iff \quad \sigma_x^2\left(\theta\sigma_f^2 + \lambda\eta\left(\sigma_f^2 + \sigma_x^2\right)\right) < 0 \\
&\iff \quad \theta < -\lambda\eta\frac{\sigma_f^2 + \sigma_x^2}{\sigma_f^2} < -\lambda\eta.
\end{aligned}$$

Therefore, when $\varphi_r^* < 0$, then the first term in the numerator of Δ_{q2} is negative and whenever the first term is negative, then the second term is negative as well. In other words, when the action has a sufficiently negative impact on cash flows (such that $\varphi_r^* < 0$), adding an ESG report reduces the fraction of shares held by ESG investors. This implies that for $\theta < 0$ and $\varphi_r^* < 0$, adding an ESG report pushes away holdings from green investors.

Proof of Corollaries 3-5

Recall from Lemma 3 that

$$\begin{aligned}
\varphi_f^* &= \frac{dp^*}{df} = \frac{\left(1+\frac{\eta^2}{S_r}\sigma_\phi^2\right)\sigma_x^2+\theta^2\sigma_\phi^2}{\left(1+\frac{\eta^2}{S_r}\sigma_\phi^2\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2}+\lambda\theta\eta\frac{\sigma_\phi^2}{\left(1+\frac{\eta^2}{S_r}\sigma_\phi^2\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2} \text{ and} \\
\varphi_r^* &= \frac{dp^*}{dr} = \frac{\theta\eta\sigma_\phi^2}{S_r}\frac{\sigma_f^2}{\left(1+\frac{\eta^2}{S_r}\sigma_\phi^2\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2}+\lambda\frac{\eta^2\sigma_\phi^2}{S_r}\frac{\sigma_f^2+\sigma_x^2}{\left(1+\frac{\eta^2}{S_r}\sigma_\phi^2\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2},
\end{aligned}$$

where $S_r = \delta^2\sigma_r^2$. Additionally, prior expectations of financial and ESG performance are:

$$\begin{aligned}
E[x^*] &= \theta\frac{1}{c_e}\left(\left(1-\frac{\sigma_f^2}{\left(1+\frac{\eta^2\sigma_\phi^2}{\delta^2\sigma_r^2}\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2}\right)\theta+\left(1-\frac{\sigma_f^2+\sigma_x^2}{\left(1+\frac{\eta^2\sigma_\phi^2}{\delta^2\sigma_r^2}\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2}\right)\lambda\eta\right) \text{ and} \\
E[y^*] &= \eta\frac{1}{c_e}\left(\left(1-\frac{\sigma_f^2}{\left(1+\frac{\eta^2\sigma_\phi^2}{\delta^2\sigma_r^2}\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2}\right)\theta+\left(1-\frac{\sigma_f^2+\sigma_x^2}{\left(1+\frac{\eta^2\sigma_\phi^2}{\delta^2\sigma_r^2}\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2}\right)\lambda\eta\right).
\end{aligned}$$

Expected financial misreporting is

$$E[f^*-x^*] = \frac{1}{c_f}\left(\frac{\left(1+\frac{\eta^2}{S_r}\sigma_\phi^2\right)\sigma_x^2+\theta^2\sigma_\phi^2}{\left(1+\frac{\eta^2}{S_r}\sigma_\phi^2\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2}+\lambda\theta\eta\frac{\sigma_\phi^2}{\left(1+\frac{\eta^2}{S_r}\sigma_\phi^2\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2}\right)$$

Derivatives with respect to λ are:

$$\begin{aligned}
\frac{d\varphi_f^*}{d\lambda} &= \theta\eta\frac{\sigma_\phi^2}{\left(1+\frac{\eta^2}{S_r}\sigma_\phi^2\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2} \propto \theta\eta, \\
\frac{d\varphi_r^*}{d\lambda} &= \frac{\eta^2\sigma_\phi^2}{S_r}\frac{\sigma_f^2+\sigma_x^2}{\left(1+\frac{\eta^2}{S_r}\sigma_\phi^2\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2} \propto \eta^2 > 0,
\end{aligned}$$

$$\begin{aligned}
\frac{d}{d\lambda}E\left[x\right] &= \frac{1}{c_e}\left(1-\frac{\sigma_f^2+\sigma_x^2}{\left(1+\frac{\eta^2\sigma_\phi^2}{\delta^2\sigma_r^2}\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2}\right)\theta\eta \propto \theta\eta, \\
\frac{d}{d\lambda}E\left[y\right] &= \frac{1}{c_e}\left(1-\frac{\sigma_f^2+\sigma_x^2}{\left(1+\frac{\eta^2\sigma_\phi^2}{\delta^2\sigma_r^2}\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2}\right)\lambda\eta^2 > 0, \text{ and} \\
\frac{d}{d\lambda}E\left[f^*-x^*\right] &= \frac{1}{c_f}\frac{\sigma_\phi^2}{\left(1+\frac{\eta^2}{S_r}\sigma_\phi^2\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2}\theta\eta \propto \theta\eta.
\end{aligned}$$

Using

$$S = \left(1+\frac{\eta^2\sigma_\phi^2}{\delta^2\sigma_r^2}\right)\left(\sigma_f^2+\sigma_x^2\right),$$

which is independent of θ, we present expressions for derivatives with respect to θ. First, for expected cash flows,

$$\begin{aligned}
\frac{d}{d\theta}E\left[x^*\right] &= \frac{1}{c_e}\left(2\left(1-\frac{\sigma_f^2}{S+\theta^2\sigma_\phi^2}\right)\theta+\left(1-\frac{\sigma_f^2+\sigma_x^2}{S+\theta^2\sigma_\phi^2}\right)\lambda\eta\right)+\frac{2}{c_e}\theta^2\sigma_\phi^2\frac{\theta\sigma_f^2+\lambda\eta\sigma_f^2+\lambda\eta\sigma_x^2}{\left(S+\theta^2\sigma_\phi^2\right)^2} \\
&= \frac{2\theta\left(\left(S+\theta^2\sigma_\phi^2\right)^2-S\sigma_f^2\right)+\left(\left(S+\theta^2\sigma_\phi^2\right)^2-S\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2\left(\sigma_f^2+\sigma_x^2\right)\right)\lambda\eta}{c_e\left(S+\theta^2\sigma_\phi^2\right)^2}.
\end{aligned}$$

Cash flows increase in the cash flow productivity for $\theta > 0$ because $S = \left(1+\frac{\eta^2\sigma_\phi^2}{\delta^2\sigma_r^2}\right)\left(\sigma_f^2+\sigma_x^2\right) \Rightarrow \left(S+\theta^2\sigma_\phi^2\right)^2 - S\sigma_f^2 > 0$, and $\left(S+\theta^2\sigma_\phi^2\right)^2 - S\left(\sigma_f^2+\sigma_x^2\right) > 0$.

For expected ESG performance,

$$\frac{d}{d\theta}E\left[y^*\right] = \eta\frac{\left(S+\theta^2\sigma_\phi^2\right)^2-S\sigma_f^2+\theta^2\sigma_f^2\sigma_\phi^2+2\lambda\theta\eta\sigma_\phi^2\left(\sigma_f^2+\sigma_x^2\right)}{c_e\left(S+\theta^2\sigma_\phi^2\right)^2}.$$

For $\theta > 0$ ESG increases in θ because, just as above, $\left(S+\theta^2\sigma_\phi^2\right)^2 - S\sigma_f^2 > 0$.

For expected financial misreporting,

$$\frac{d}{d\theta}E\left[f^*-x^*\right] = \sigma_\phi^2\frac{2S\theta\sigma_f^2+\lambda\eta\left(\sigma_f^2+\sigma_x^2\right)\left(S-\theta^2\sigma_\phi^2\right)}{c_f\left(\sigma_f^2+\sigma_x^2\right)\left(S+\theta^2\sigma_\phi^2\right)^2}.$$

We have $\frac{d}{d\theta}E\left[f^*-x^*\right]>0$ when $2S\theta\sigma_f^2+\lambda\eta\left(\sigma_f^2+\sigma_x^2\right)\left(S-\theta^2\sigma_\phi^2\right)>0$.

For expected ESG misreporting,

$$\frac{d}{d\theta}E\left[r^*-y^*\right] = \frac{1}{c_r}\frac{\eta\sigma_\phi^2}{\delta^2\sigma_r^2}\left(\sigma_f^2\frac{S-\theta^2\sigma_\phi^2}{\left(S+\theta^2\sigma_\phi^2\right)^2}-2\theta\lambda\eta\sigma_\phi^2\frac{\sigma_f^2+\sigma_x^2}{\left(S+\theta^2\sigma_\phi^2\right)^2}\right)$$

Thus, $\frac{d}{d\theta}E\left[r^*-y^*\right]$ is positive whenever $\sigma_f^2\left(S(\sigma_f^2+\sigma_x^2)-\theta^2\sigma_\varphi^2\right)-2\theta\lambda\eta\sigma_\varphi^2\left(\sigma_f^2+\sigma_x^2\right)>0$.

Sensitivities of equilibrium price responses to the reports are affected by changes in σ_x^2 as follows:

$$\begin{aligned}
\frac{d\varphi_f^*}{d\sigma_x^2} &= \frac{d}{d\sigma_x^2}\left(\frac{\left(1+\frac{\eta^2}{S_r}\sigma_\phi^2\right)\sigma_x^2+\theta^2\sigma_\phi^2}{\left(1+\frac{\eta^2}{S_r}\sigma_\phi^2\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2}+\lambda\theta\eta\frac{\sigma_\phi^2}{\left(1+\frac{\eta^2}{S_r}\sigma_\phi^2\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2}\right)\\
&= \left(1+\frac{\eta^2}{S_r}\sigma_\phi^2\right)\frac{\sigma_f^2+\frac{\eta^2}{S_r}\sigma_f^2\sigma_\phi^2-\theta\lambda\eta\sigma_\phi^2}{\left(\left(1+\frac{\eta^2}{S_r}\sigma_\phi^2\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2\right)^2} \text{ and}\\
\frac{d\varphi_r^*}{d\sigma_x^2} &= \frac{d}{d\sigma_x^2}\left(\frac{\eta\theta\sigma_\phi^2}{S_r}\frac{\sigma_f^2}{\left(1+\frac{\eta^2}{S_r}\sigma_\phi^2\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2}+\lambda\frac{\eta^2\sigma_\phi^2}{S_r}\frac{\sigma_f^2+\sigma_x^2}{\left(1+\frac{\eta^2}{S_r}\sigma_\phi^2\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2}\right)\\
&= -\frac{\eta}{S_r}\theta\sigma_\phi^2\frac{\sigma_f^2+\frac{\eta^2}{S_r}\sigma_f^2\sigma_\phi^2-\theta\lambda\eta\sigma_\phi^2}{\left(\left(1+\frac{\eta^2}{S_r}\sigma_\phi^2\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2\right)^2}.
\end{aligned}$$

Thus,

$$\begin{aligned}
\frac{d\varphi_f^*}{d\sigma_x^2} &\propto \sigma_f^2\left(1+\frac{\eta^2}{S_r}\sigma_\phi^2\right)-\theta\lambda\eta\sigma_\phi^2 \text{ and}\\
\frac{d\varphi_r^*}{d\sigma_x^2} &\propto -\left(\sigma_f^2\left(1+\frac{\eta^2}{S_r}\sigma_\phi^2\right)-\theta\lambda\eta\sigma_\phi^2\right),
\end{aligned}$$

where "$\propto$" can be read as "is proportional to" and implies "has the same sign as."

Denote $Q=\frac{\eta^2\sigma_\phi^2}{\delta^2\sigma_r^2}>0$. Then we can express the remaining comparative statics with

respect to σ_x^2 as:

$$\begin{aligned}
\frac{\partial}{\partial \sigma_x^2} E\left[x^*\right] &= \frac{1}{c_e}\theta^2 \frac{\left(1+Q\right)\sigma_f^2 - \lambda\theta\eta\sigma_\phi^2}{\left(\sigma_x^2+\sigma_f^2+\theta^2\sigma_\phi^2+Q\sigma_f^2+Q\sigma_x^2\right)^2}, \\
\frac{\partial}{\partial \sigma_x^2} E\left[y^*\right] &= \frac{1}{c_e}\theta\eta \frac{\left(1+Q\right)\sigma_f^2 - \theta\lambda\eta\sigma_\phi^2}{\left(\sigma_x^2+\sigma_f^2+\theta^2\sigma_\phi^2+Q\sigma_f^2+Q\sigma_x^2\right)^2}, \\
\frac{\partial}{\partial \sigma_x^2} E\left[f^*-x^*\right] &= \frac{1+Q}{c_f} \frac{\left(Q+1\right)\sigma_f^2 - \lambda\theta\eta\sigma_\phi^2}{\left(\sigma_x^2+\sigma_f^2+\theta^2\sigma_\phi^2+Q\sigma_f^2+Q\sigma_x^2\right)^2}, \text{ and} \\
\frac{\partial}{\partial \sigma_x^2} E\left[r^*-y^*\right] &= -\theta\frac{Q}{c_r} \frac{\left(1+S\right)\sigma_f^2 - \theta\lambda\eta\sigma_\phi^2}{\eta\left(\sigma_x^2+\sigma_f^2+\theta^2\sigma_\phi^2+Q\sigma_f^2+Q\sigma_x^2\right)^2}.
\end{aligned}$$

For $\theta < 0$, we have:

$$\begin{aligned}
\frac{\partial}{\partial \sigma_x^2} E\left[x^*\right] &= \frac{1}{c_e}\theta^2 \frac{\left(1+Q\right)\sigma_f^2 - \lambda\theta\eta\sigma_\phi^2}{\left(\sigma_x^2+\sigma_f^2+\theta^2\sigma_\phi^2+Q\sigma_f^2+Q\sigma_x^2\right)^2} > 0, \\
\frac{\partial}{\partial \sigma_x^2} E\left[y^*\right] &= \frac{1}{c_e}\theta\eta \frac{\left(1+Q\right)\sigma_f^2 - \theta\lambda\eta\sigma_\phi^2}{\left(\sigma_x^2+\sigma_f^2+\theta^2\sigma_\phi^2+Q\sigma_f^2+Q\sigma_x^2\right)^2} < 0, \text{ and} \\
\frac{\partial}{\partial \sigma_x^2} E\left[f^*-x^*\right] &= \frac{1+Q}{c_f} \frac{\left(Q+1\right)\sigma_f^2 - \lambda\theta\eta\sigma_\phi^2}{\left(\sigma_x^2+\sigma_f^2+\theta^2\sigma_\phi^2+Q\sigma_f^2+Q\sigma_x^2\right)^2} > 0.
\end{aligned}$$

For $\theta > 0$ and $\left(1+Q\right)\sigma_f^2 - \lambda\theta\eta\sigma_\phi^2 > 0$:

$$\begin{aligned}
\frac{\partial}{\partial \sigma_x^2} E\left[x\right] &= \frac{1}{c_e}\theta^2 \frac{\left(1+Q\right)\sigma_f^2 - \lambda\theta\eta\sigma_\phi^2}{\left(\sigma_x^2+\sigma_f^2+\theta^2\sigma_\phi^2+S\sigma_f^2+Q\sigma_x^2\right)^2} > 0, \\
\frac{\partial}{\partial \sigma_x^2} E\left[y\right] &= \frac{1}{c_e}\theta\eta \frac{\left(1+Q\right)\sigma_f^2 - \theta\lambda\eta\sigma_\phi^2}{\left(\sigma_x^2+\sigma_f^2+\theta^2\sigma_\phi^2+Q\sigma_f^2+Q\sigma_x^2\right)^2} > 0, \text{ and} \\
\frac{\partial}{\partial \sigma_x^2} E\left[f^*-x^*\right] &= \frac{1+Q}{c_f} \frac{\left(Q+1\right)\sigma_f^2 - \lambda\theta\eta\sigma_\phi^2}{\left(\sigma_x^2+\sigma_f^2+\theta^2\sigma_\phi^2+Q\sigma_f^2+Q\sigma_x^2\right)^2} > 0.
\end{aligned}$$

For $\theta > 0$ and $(1+Q)\,\sigma_f^2 - \lambda\theta\eta\sigma_\phi^2 < 0$:

$$\begin{aligned}
\frac{\partial}{\partial\sigma_x^2}E\left[x\right] &= \frac{1}{c_e}\theta^2\frac{(1+Q)\,\sigma_f^2 - \lambda\theta\eta\sigma_\phi^2}{\left(\sigma_x^2+\sigma_f^2+\theta^2\sigma_\phi^2+Q\sigma_f^2+Q\sigma_x^2\right)^2} < 0,\\
\frac{\partial}{\partial\sigma_x^2}E\left[y\right] &= \frac{1}{c_e}\theta\eta\frac{(1+Q)\,\sigma_f^2 - \theta\lambda\eta\sigma_\phi^2}{\left(\sigma_x^2+\sigma_f^2+\theta^2\sigma_\phi^2+Q\sigma_f^2+Q\sigma_x^2\right)^2} < 0, \text{ and}\\
\frac{\partial}{\partial\sigma_x^2}E\left[f^*-x^*\right] &= \frac{1+Q}{c_f}\frac{(Q+1)\,\sigma_f^2 - \lambda\theta\eta\sigma_\phi^2}{\left(\sigma_x^2+\sigma_f^2+\theta^2\sigma_\phi^2+Q\sigma_f^2+Q\sigma_x^2\right)^2} < 0.
\end{aligned}$$

$\delta^2\sigma_r^2$ always appears as a product in the expressions together. That is why instead of taking derivatives with respect to δ^2 and σ_r^2 separately, we take the derivatives with respect to $S_r = \delta^2\sigma_r^2$. Since both δ^2 and σ_r^2 are positive, the chain rule implies that derivatives with respect to δ^2 and σ_r^2 individually will be proportional to the derivatives with respect to S_r.

$$\begin{aligned}
\frac{d\varphi_f^*}{dS_r} &= \frac{d}{dS_r}\left(\frac{\left(1+\frac{\eta^2}{S_r}\sigma_\phi^2\right)\sigma_x^2+\theta^2\sigma_\phi^2}{\left(1+\frac{\eta^2}{S_r}\sigma_\phi^2\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2} + \lambda\theta\eta\frac{\sigma_\phi^2}{\left(1+\frac{\eta^2}{S_r}\sigma_\phi^2\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2}\right)\\
&= \frac{\frac{\sigma_\phi^2}{S_r}}{\left(1+\frac{\eta^2}{S_r}\sigma_\phi^2\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2}\eta\theta\varphi_r^*.\\
\frac{d\varphi_r^*}{dS_r} &= \frac{d}{dS_r}\left(\frac{\eta\theta\sigma_\phi^2}{S_r}\frac{\sigma_f^2}{\left(1+\frac{\eta^2}{S_r}\sigma_\phi^2\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2} + \lambda\frac{\eta^2\sigma_\phi^2}{S_r}\frac{\sigma_f^2+\sigma_x^2}{\left(1+\frac{\eta^2}{S_r}\sigma_\phi^2\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2}\right)\\
&= -\frac{\sigma_f^2+\sigma_x^2+\theta^2\sigma_\phi^2}{S_r\left(1+\frac{\eta^2}{S_r}\sigma_\phi^2\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2}\varphi_r^*.
\end{aligned}$$

Furthermore,

$$\begin{aligned}
\frac{d}{dS_r}E\left[x\right] &= -\theta\frac{1}{c_e}\frac{\eta^2\sigma_\phi^2}{S_r^2}\left(\sigma_f^2+\sigma_x^2\right)\frac{\theta\sigma_f^2+\lambda\eta\left(\sigma_f^2+\sigma_x^2\right)}{\left(\left(1+\frac{\eta^2\sigma_\phi^2}{S_r}\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2\right)^2} \propto -\theta\varphi_r^*,\\
\frac{d}{dS_r}E\left[y\right] &= -\eta\frac{\eta^2\sigma_\phi^2}{S_r^2}\left(\sigma_f^2+\sigma_x^2\right)\frac{\theta\sigma_f^2+\lambda\eta\left(\sigma_f^2+\sigma_x^2\right)}{c_e\left(\left(1+\frac{\eta^2\sigma_\phi^2}{S_r}\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2\right)^2} \propto -\varphi_r^*, \text{ and}\\
\frac{d}{dS_r}E\left[f^*-x^*\right] &= \theta\frac{\eta^2\sigma_\phi^4}{S_r^2}\frac{\theta\sigma_f^2+\lambda\eta\left(\sigma_f^2+\sigma_x^2\right)}{c_f\left(\left(1+\frac{\eta^2\sigma_\phi^2}{S_r}\right)\left(\sigma_f^2+\sigma_x^2\right)+\theta^2\sigma_\phi^2\right)^2} \propto \theta\varphi_r^*
\end{aligned}$$

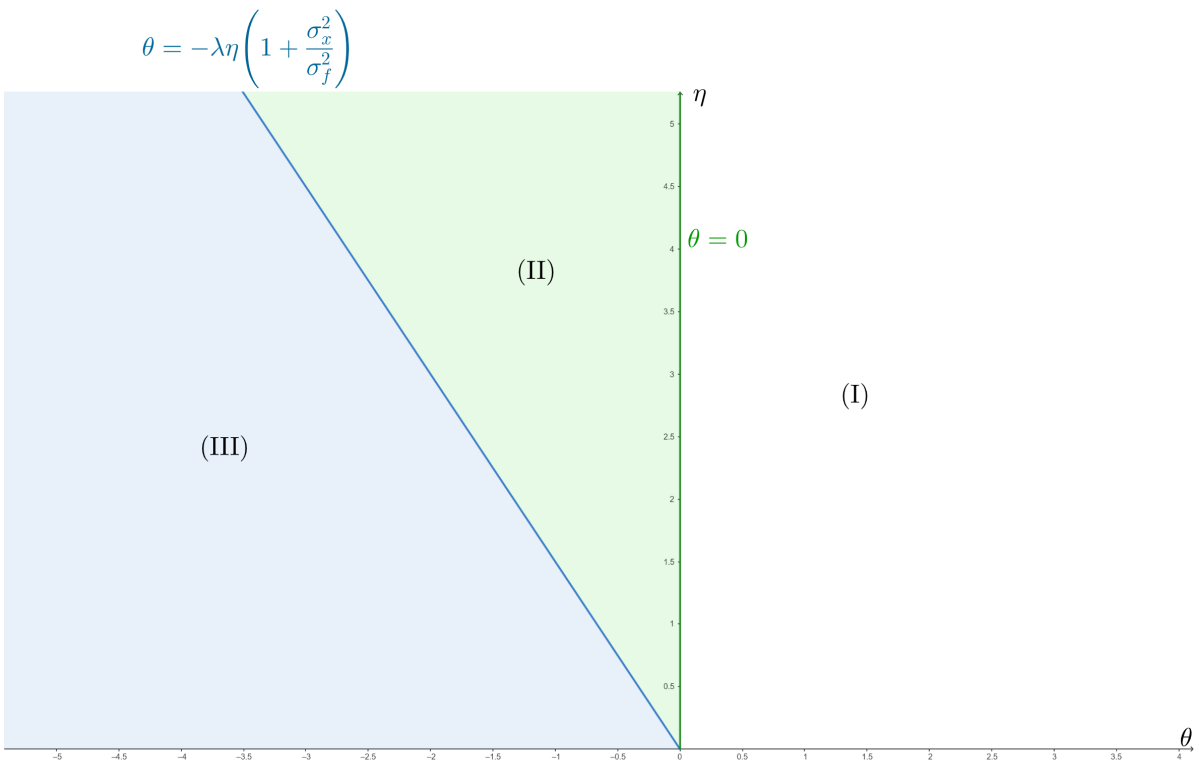

Figure 1: Regions of θ and η where the effects of introducing ESG reporting on ERC, expected cash flows, and ESG performance are different. $\lambda = \frac{1}{3}, \sigma_x^2 = 1$, and $\sigma_f^2 = 1$. In region (I), after the introduction of ESG reporting, the ERC decreases, and expected cash flows and ESG performance increase. In region (II), after the introduction of ESG reporting, the ERC increases, expected cash flows decrease, and expected ESG performance increases. In region (III), the ERC decreases, expected cash flows increase, and expected ESG performance decreases.

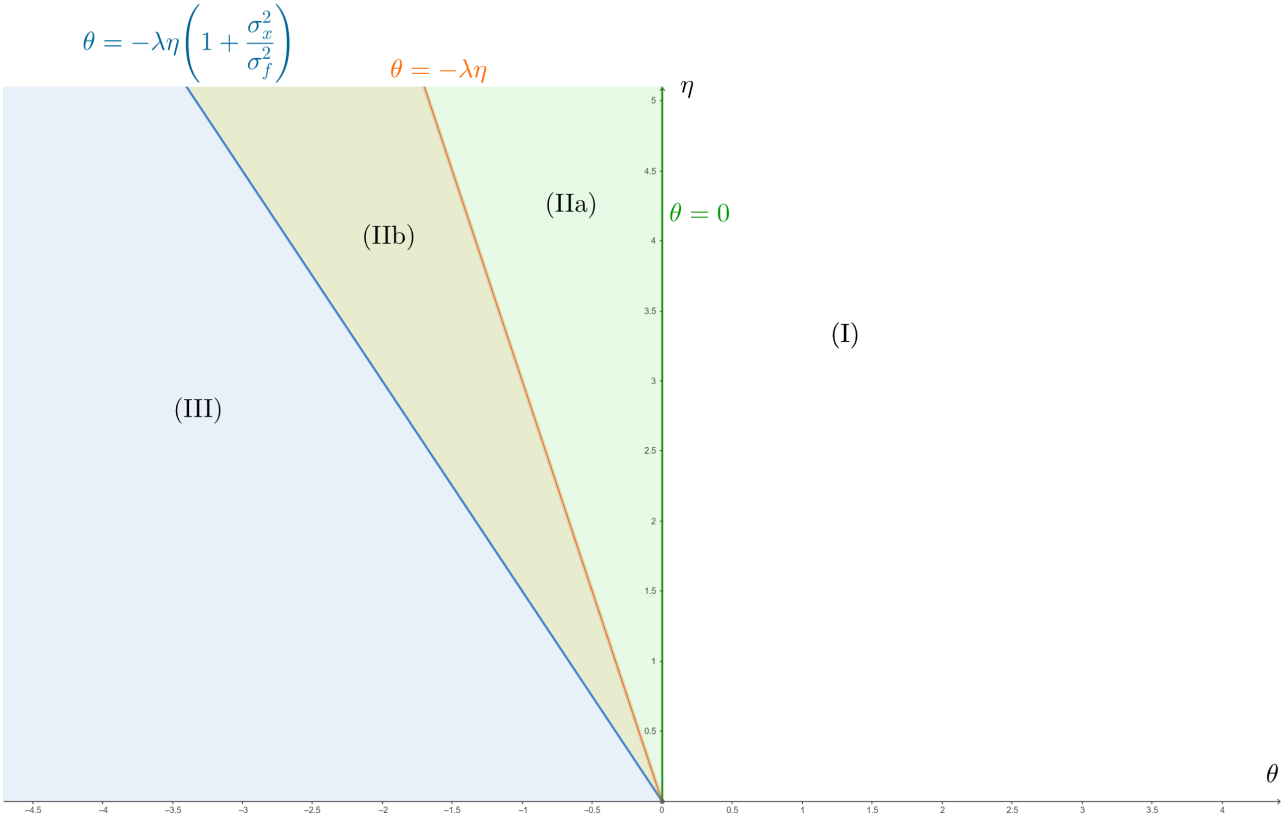

Figure 2: Regions of θ and η where the effects of introducing ESG reporting on expected cash flows, ESG performance, and prices are different. $\lambda = \frac{1}{3}, \sigma_x^2 = 1,$ and $\sigma_f^2 = 1$. The plots assume no impact of ESG reporting on risk premium. In region (I), after the introduction of ESG reporting, the firm's price increases, the ERC decreases, and expected cash flows and ESG performance increase. In region (IIa), the firm's price increases, the ERC increases, expected cash flows decrease, and expected ESG performance increases. In region (IIb), the firm's price decreases, the ERC increases, expected cash flows decrease, and expected ESG performance increases. In region (III), the firm's price increases, the ERC decreases, expected cash flows increase, and expected ESG performance decreases.

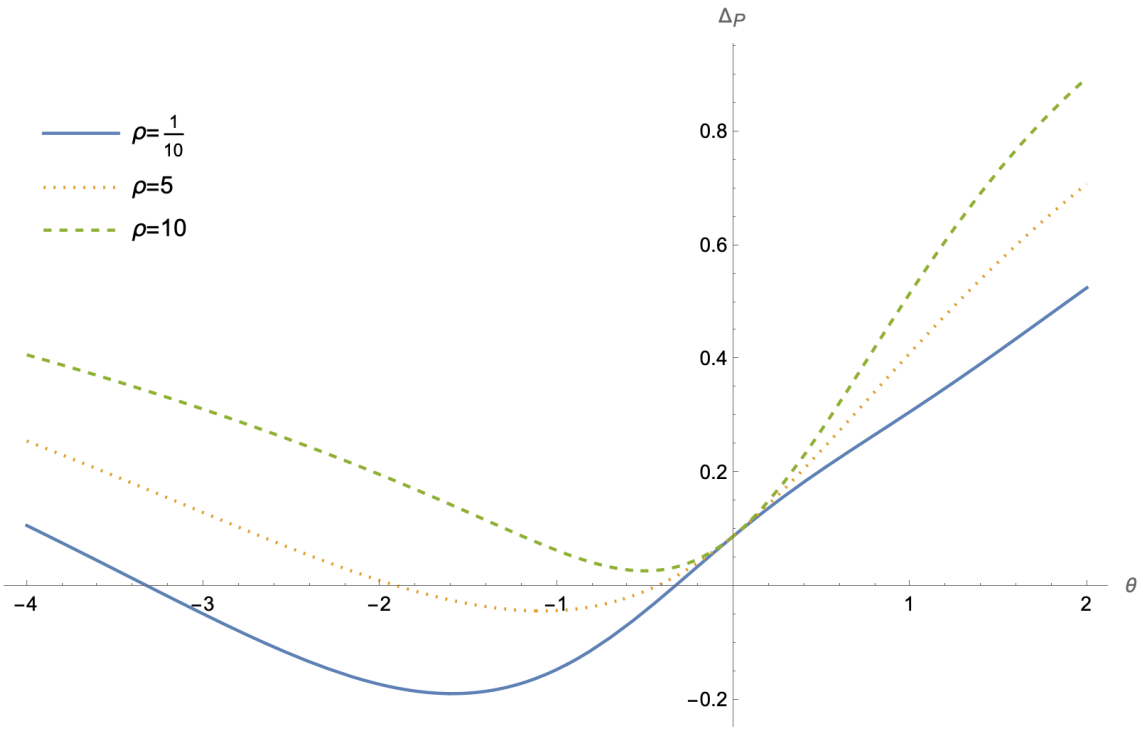

Figure 3: Expected price change after the introduction of ESG reporting as a function of θ, for different levels of investors' risk aversion ρ. Other parameters are set as: $\lambda = \frac{1}{3}$, $\eta = 1$, $c_e = 1$, $\sigma_x^2 = 3$, $\sigma_\phi^2 = 2$, $\delta = 1$, $\sigma_f^2 = 1$, $\sigma_r^2 = 1$.

Table 1: Impacts of introducing ESG reporting

Effect on \ Parameter region	$\theta > 0$	$0 > \theta > -\lambda\eta$	$0 > \theta > -\lambda\eta\left(1+\frac{\sigma_x^2}{\sigma_f^2}\right)$	$-\lambda\eta\left(1+\frac{\sigma_x^2}{\sigma_f^2}\right) > \theta$
ERC (Δ_ϕ)	-	+	+	-
Price (Δ_P)	+	+/-	+/-	+
Expected cash flows (Δ_x)	+	-	-	+
Expected ESG performance (Δ_y)	+	+	+	-
ESG investors' holdings (Δ_{q_2})	+	+	+/-	-
Traditional investors' holdings (Δ_{q_1})	-	-	+/-	+

Table 2: Impacts of increases in parameters when the firm provides both reports

Effect on \ Parameter region	**Fraction of investors who value ESG performance (λ)**	**Cash flow implications of ESG efforts (θ)**	**Importance of non-ESG cash flow (σ_x^2)**	**Idiosyncratic ESG reporting incentives (δ or σ_r^2)**
Price response to ESG report ($\phi_r^\ddagger$)	+	+/-	$sign(-Z_3)$	+ for $\theta < Z_4$, - otherwise
Expected ESG performance ($E[y^\ddagger]$)	+	$sign(\theta)$	$sign(\theta Z_3)$	+ for $\theta < Z_4$, - otherwise
Expected Greenwashing / ESG misreporting ($\frac{\phi_r^\ddagger}{c_r}$)	+	$sign(Z_2)$	$sign(-\theta Z_3)$	+ for $\theta < Z_4$, - otherwise
ERC ($\phi_f^\ddagger$)	$sign(\theta)$	+/-	$sign(Z_3)$	+ for $\theta > 0$ or $\theta < Z_4$, - otherwise
Expected cash flows ($E[x^\ddagger]$)	$sign(\theta)$	$sign(\theta)$	$sign(Z_3)$	+ for $0 > \theta > Z_4$, - otherwise
Expected financial misreporting ($f^\ddagger - x^\ddagger$)	$sign(\theta)$	$sign(Z_1)$	$sign(Z_3)$	+ for $\theta > 0$ or $\theta < Z_4$, - otherwise

$Z_1 = 2S\theta\sigma_f^2 + \lambda\eta\left(S\left(\sigma_f^2+\sigma_x^2\right) - \theta^2\sigma_\phi^2\right), Z_2 = \sigma_f^2\left(S\left(\sigma_f^2+\sigma_x^2\right) - \theta^2\sigma_\phi^2\right) - 2\theta\lambda\eta\sigma_\phi^2\left(\sigma_f^2+\sigma_x^2\right), Z_3 = (1+S)\sigma_f^2 - \lambda\theta\eta\sigma_\phi^2, Z_4 = -\lambda\eta\frac{\sigma_f^2+\sigma_x^2}{\sigma_f^2}, S = 1 + \frac{\eta^2\sigma_\phi^2}{\delta^2\sigma_r^2}.$