# The Real Effects of Mandatory ESG Disclosure

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**Abstract**

Policymakers increasingly advocate mandatory ESG disclosure. This paper studies how ESG disclosure affects investment decisions in a signal-jamming model where managers face pressure to improve stock price and ESG performance. I find, first, ESG transparency elicits improvements in ESG outcomes because it stimulates stakeholder pressure to enhance nonfinancial performance. Second, ESG disclosure impairs the value relevance of financial information if there is information asymmetry between investors, non-investor stakeholders, and managers. This effect is financially beneficial because it reduces under-investment, but boosts investments regardless of their environmental impact. Third, with information asymmetry, the net environmental effect of ESG disclosure is positive if stakeholder pressure is sufficiently high. Fourth, if the impact of transitory influences on financial performance is inversely related to their variance, the stock price's sensitivity to financial performance can increase with the transitory components' variance. Finally, the model shows ESG disclosure causes endogeneity problems in OLS value relevance estimates.

**Keywords:** real effects, mandatory ESG disclosure, stock price and stakeholder pressure

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# 1 Introduction

SASB (2020, p.1) states: "to secure the future of our people and our planet [...] reporting is an important means". In this paper, I examine the effect of mandatory ESG disclosure on a firm's financial and nonfinancial performance in an analytical model. The model consists of three players: a manager who makes publicly unobservable investment decisions, short-run oriented investors that motivate managers to act myopically, and ESG-interested stakeholders that pressure firms to enhance ESG performance.[1] In contrast to the notion that ESG transparency unambiguously benefits ESG performance, I find conditions under which mandatory ESG disclosure worsens a firm's environmental impact. Key to this finding is a change in the investors' sensitivity to financial information following ESG disclosure. For example, if investors can infer long-run expenses associated with ESG performance more accurately from ESG than from short-run financial performance, the stock price's sensitivity to short-run financial performance declines following ESG disclosure. Managers are, therefore, more willing to make costly investment decisions in the short-run. This change in management decisions is independent of the investments' environmental impact, hence can lead to the outcome that ESG disclosure worsens ESG performance. The paper sets out to provide a more nuanced view of the real effects of mandatory ESG disclosure by highlighting both beneficial and detrimental consequences of ESG transparency.

I derive three effects of mandatory ESG disclosure: Firstly, there is a change in the investor's sensitivity to short-run financial performance, which can arise as described above. This effect is referred to as "signal-jamming effect" because a change in this sensitivity affects the manager's incentives to "jam" and alter short-run financial performance that investors use as a signal for long-run profitability. The existence of this effect rests on information asymmetry between investors and non-investor stakeholders, i.e. is sensitive to differences in the players' information sets. Secondly, more precise ESG information implies the stakeholders' expectations of environmental performance reflect the firm's true environmental impact more accurately and increases the stakeholders' responsiveness to this information. Financial benefits of strong ESG performance, such as high demand from socially responsible consumers, thus increase with more precise ESG disclosure. This effect is referred to as "stakeholder effect". Thirdly, the stock price reacts more positively (negatively) to

[1] I refer to individuals and organizations that have an interest in financial and nonfinancial performance as investors and (non-investor or ESG-interested) stakeholders, respectively. Although ESG performance comprises many issues other than environmental performance, "ESG performance" and "environmental performance" are used interchangeably because the paper focuses on a firm's environmental impact.

a given level of strong (poor) ESG performance if there is precise ESG disclosure. The reason is that the stock price varies with the investors' expectations of financial performance and, because of the stakeholder effect, this expectation is higher (lower) for strong (poor) ESG performance if there is truthful ESG disclosure. This effect is labeled as "direct stock price effect" of mandatory ESG disclosure. The three effects exist regardless of whether managers or investors have altruistic preferences for strong ESG performance, or not. I show that whilst the latter two effects induce real effects that strictly enhance ESG performance, the signal-jamming effect can work as a counter-acting force. The paper establishes the conditions when a given effect is particularly pronounced. For example, the stakeholder effect is weak, the signal-jamming dominates, and mandatory ESG disclosure can be environmentally detrimental if ESG-interested stakeholders have little influence on a firm's financial performance.

The analysis can reconcile why there exist empirical studies that find a positive, and others that find a negative, association between nonfinancial disclosure and financial performance (e.g. Ioannou and Serafeim, 2017; Chen et al., 2018). Depending on the extent of stakeholder pressure for strong ESG performance, firms internalize the costs and benefits of their environmental impact differently. I find that only if stakeholder pressure exceeds a threshold, firms have sufficient incentives to go green such that disclosing ESG performance reveals they are an "environmentally friendly" business and, in turn, reaps financial rewards from ESG-interested stakeholders. Furthermore, I show that the decline in the stock price's sensitivity to short-run financial performance following mandatory ESG disclosure is financially beneficial because it reduces inefficient under-investment.

The findings generally suggest that the stock price's sensitivity to financial performance need not decrease with the variance of transitory, random influences on financial performance. If such influences stem from stakeholder pressure that is based on imprecise information (e.g. overstatements in newspaper articles), their impact on financial performance is inversely related to their variance. Since a higher variance lowers the transitory component's impact on financial performance, the stock price's sensitivity to financial performance can increase with the variance of transitory influences. In prior literature, an increase in the variance of transitory noise typically causes a strict decline in the stock price reaction to financial performance (see e.g. Holthausen and Verrecchia, 1988).

The model builds on the seminal papers of Kanodia (1980) and Stein (1989) that demonstrate how stock market pressure induces changes in management decisions. I contribute to the real effects literature by explicitly modeling a firm's environmental impact, mandatory ESG disclosure, and financial pressure from non-investor stakeholders for strong ESG performance. These model characteristics have not yet been studied in analytical "Kanodia-Stein" real effects papers. The analysis underlines that ultimately both financial and nonfinancial information, and particularly related pressure from investors as well as non-investor stakeholders, influence decisions and welfare implications thereof.

The paper is organized as follows: Section 2 discusses related research and literature gaps that this paper addresses. Section 3 presents the analytical real effects model. Section 4 analyzes various settings that differ in the nonfinancial information of stakeholders and investors, compares the financial and nonfinancial performance of different disclosure regimes, and discusses complications that can arise in empirical value relevance estimates. Finally, section 5 concludes.

## 2 Related Literature

There are various global efforts to standardize and mandate nonfinancial reporting. Both EFRAG (2020) and the IFRS Foundation (2020) currently develop sustainability reporting standards. Following SASB's (2020) statement of intent to work together with other integrated reporting organizations (i.e. CDP, CDSB, GRI, and IIRC), in November 2020 SASB announced their plan to merge with the IIRC to set sustainability standards jointly. On the one hand, investors increasingly demand information beyond traditional financial disclosures to comprehensively assess firm value (Bolton and Kacperczyk, 2021). On the other hand, global standardsetters and policymakers aim to advance sustainability goals through more transparency of nonfinancial information. Such targeted transparency is e.g. part of the European Commission's "Action Plan: Financing Sustainable Growth" that seeks to contribute to the Paris Agreement and the UN Sustainable Development Goals (EC, 2018). The Security and Exchange Commission also requires disclosing the use of "conflict minerals" and workplace safety information of the mining industry to enhance corporate social responsibility (Lynn, 2011).

Whether and how targeted ESG transparency changes corporate behavior and performance remains a partly open research question. Existing studies on the real effects of nonfinancial reporting are predominantly empirical research. Christensen et al. (2017) focus on the US mining industry and investigate mandatory disclosure of workplace safety issues in 10 K's. They find a positive effect on employee safety, but a negative effect on productivity. Similarly, Chen et al. (2018) show mandatory nonfinancial disclosure improves a firm's environmental performance but is disadvantageous for profitability. Downar et al. (2021) find a reduction in carbon emissions but no change in financial operating performance following mandatory carbon emissions disclosure in the UK. However, Ioannou and Serafeim (2017) conclude that, on average, mandatory ESG disclosures increase Tobin's Q and firm value. In section 4.2.2 of this paper, I provide a theoretical explanation for conflicting empirical findings of the association between mandatory ESG disclosure and financial performance. Fiechter et al. (2020) study the real effects of the EU Directive 2014/95/EU. They show that companies in countries with weak ESG-related institutions experienced the largest improvements in ESG performance after the disclosure mandate. To the extent that weak ESG-related institutions imply that there is less ESG information prior to the mandate, their finding is consistent with my theoretical results. The reason is that the signal-jamming effect, which can impair ESG improvements post mandatory ESG disclosure, is magnified when ESG-interested stakeholders observe imprecise nonfinancial information ahead of mandatory disclosure.

Based on Fama and French (2007), Friedman and Heinle (2016) examine nonfinancial reporting and preferences for sustainability in an analytical model. In their setting, there is an exogenous fraction of risk-averse investors that value strong ESG performance beyond its cash flow implications. Similarly, Pástor et al. (2021) model agents with different preferences for ESG criteria. By contrast, I assume risk-neutral investors without altruistic preferences for strong ESG performance. Consistent with Amel-Zadeh and Serafeim (2018, p.92) suggesting that the investors' interest in ESG information has primarily "financial rather than ethical motives", investors care about nonfinancial performance because of its impact on financial performance in my paper. This impact arises endogenously from the stakeholders' disclosure-influenced expectations of the firm's environmental impact. As such, the paper complements Friedman and Heinle (2016) by explicitly modeling why investors may have preferences for corporate social responsibility and how their preferences and valuation change with mandatory ESG disclosure. As I demonstrate in Appendix B, my findings are, however, robust to assuming that investors have intrinsic preferences for strong ESG performance beyond its financial implications.

Theoretical real effects research has focused on financial disclosure and built on Kanodia (1980) and Stein (1989). Kanodia and Sapra (2016) extensively discuss this literature. In short, the investors' valuation of a firm's future profitability impacts stock prices. Managers care about stock prices because of e.g. compensation schemes and can influence the market valuation through management decisions. If investors have less information on investment decisions or project types than the manager and are (partly) impatient such that they sell their stocks in the short-run, changes in accounting disclosure induce changes in management decisions. Kanodia (1980) first outlined this feedback loop in a dynamic general equilibrium model. In related papers, Kanodia and Mukherji (1996) and Kanodia et al. (2004) study the real effects of separating investments from operating cash flows and measuring intangible assets, respectively. In these examples as well as in my model, there is information asymmetry between the manager and firm-external players because of unobservable management decisions. Such information asymmetry typically generates economically inefficient under-investment compared to a full information benchmark. In contrast, e.g. Bebchuk and Stole (1993) and Kanodia and Lee (1998) study the real effects of information asymmetry regarding the investments' productivity, which leads to over-investment when the management decisions are observable. Kanodia et al. (2005) combine both hidden management actions and hidden productivity in a real effects model. I present a real effects model with hidden actions and examine ESG reporting, sustainability investments, and stakeholder pressure that generates revenues or costs based on the stakeholders' expectations of corporate ESG performance. That is, corporate disclosures do not only affect the investors' expectations and hence stock prices, but also impact expectations and of non-investor stakeholders that influence the financial performance that investors attempt to predict.

Prior research identifies various channels through which ESG disclosure or related stakeholder pressure affect corporate financial performance. Jin and Leslie (2003) show that ESG disclosure influences consumer demand. Some organizations and consumers are willing to pay more for eco-friendly products or abstain from contracting suppliers that are associated with poor ESG values (Baron, 2008; Bagnoli and Watts, 2019; Dai et al., 2020). Public-shaming or NGO campaigns can result in reputational costs (Benabou and Tirole, 2006; Rauter, 2020), governments impose fines for breaking environmental laws and promote green business through grants or loans, and there are indirect financial benefits of sustainability through e.g. greater employee loyalty (Greening and Turban, 2000).[2] Moreover, Grewal et al. (2019) find stock market reactions to anticipated proprietary and political costs of mandatory ESG disclosure.

If ESG disclosure generates stakeholder pressure with financial repercussions, nonfinancial in-

[2]Anecdotal evidence emphasizes NGO campaigns exert financial pressure onto firms. For example, in a newspaper interview Lisa Morden, Kimberly-Clark's director for global sustainability admitted that the reputational damage of a Greenpeace campaign "was becoming challenging, commercially" (Gunther, 2015). Christensen et al. (2018) and Hombach and Sellhorn (2019) provide detailed reviews of the economic effects of stakeholder pressure.

formation should affect the decisions of profit-maximizing managers. Christensen et al. (2018, p.137) analyze the literature on ESG reporting and conclude that: ”The use of this information by non-investor stakeholders creates the potential for (additional) real effects (or firm responses).” Although prior research implies that ESG disclosure creates stakeholder pressure and affects corporate decisions, there is no formal theoretical analysis that jointly investigates the real effects of financial and nonfinancial information when there is pressure from both investors and non-investor stakeholders. The model below sets out to address this research gap.

# 3 Model

## 3.1 Earnings Process

This section discusses how the manager's decisions affect the firm's short- and long-run financial performance. At date $t = 0$, the manager decides the level of an investment in the firm's main business activity $q$ and in sustainability $s$. Both $q$ and $s$ have a direct and an indirect effect on the firm's expected financial performance at $t = 1$ and $t = 2$. The direct effect represents the costs and financial benefits associated with choices $q$ and $s$ absent of any stakeholder pressure for strong ESG performance. The indirect financial effect stems from the additional costs and benefits that the firm incurs because some stakeholders care about the firm's environmental impact. Direct revenues from the main business activity $\tilde{R}$ and direct financial benefits of sustainability investments $\tilde{B}_s$ are equal to:

$$\tilde{R} = \theta q + \tilde{r} \tag{1}$$

$$\tilde{B}_s = b_s s + \tilde{\eta} \tag{2}$$

$\theta$ and $b_s$ represent the marginal (direct) revenues of $q$ and $s$. $\tilde{r} \sim N(0, \sigma^2_{\tilde{r}})$ and $\tilde{\eta} \sim N(0, \sigma^2_{\tilde{\eta}})$ account for the fundamental revenue streams associated with the main business activity and sustainability investments that do not vary with the manager's choices of $q$ and $s$. The total cost of $q$ and $s$ is:

$$\tilde{C} = c(q, s) + \tilde{\gamma} \tag{3}$$

where $\tilde{\gamma} \sim N(0, \sigma^2_{\tilde{\gamma}})$. $\tilde{\gamma}$ captures random cost over- or under-runs that could e.g. arise because of unforeseeable production hold-ups. I assume $c(q, s) = \frac{q^2}{2} + \frac{s^2}{2}$ to derive a closed-form solution and costs are fully incurred at $t = 1$. Since total costs are additive in $q$ and $s$, the manager invests in both $q$ and $s$.[3] The quadratic cost terms are strictly increasing and convex in the corresponding investment. They ensure that the solutions of the utility maximization problem are indeed maxima in this model.

Moreover, investments $q$ and $s$ influence the firm's environmental impact at $t = 1$:

$$\tilde{I} = \beta_s s - \beta_q q + \tilde{i}. \tag{4}$$

$\tilde{i} \sim N(0, \sigma^2_{\tilde{i}})$ is the fundamental environmental impact when $q$ and $s$ are zero. $\tilde{I} > 0$ ($\tilde{I} < 0$) indicates an environmentally beneficial (harmful) impact, whereby the firm's positive (negative) impact increases with a higher (lower) $\tilde{I}$. $\beta_s > 0$ and $\beta_q > 0$ represent the change in $\tilde{I}$ if the manager marginally raises the respective investment. The functional form of $\tilde{I}$ incorporates that $s$ is advantageous ($\frac{\partial \tilde{I}}{\partial s} > 0$) and $q$, e.g. because of damaging externalities, is disadvantageous to ESG performance ($\frac{\partial \tilde{I}}{\partial q} < 0$).[4] ESG-interested stakeholders care about the overall environmental impact $\tilde{I}$ of the firm's operations. Since $\tilde{I}$ is not publicly observable, these stakeholders need to form expectations of $\tilde{I}$ based on their information set $\Phi^{ST}$. That is, stakeholders form $E[\tilde{I}|\Phi^{ST}]$. A change in these expectations elicits changes in stakeholder pressure, which subsequently has financial consequences. I refer to actions or outcomes that are induced by the stakeholders' expectations of $\tilde{I}$ and that have financial consequences as "stakeholder pressure". Examples include demand from environmentally responsible consumers or corporate reputation that vary with the public perception of the firm's environmental impact (see section 2). The financial repercussions of stakeholder pressure are:

$$\tilde{S}_t = pE[\tilde{I}|\Phi^{ST}_{t-k}] \tag{5}$$

Whilst $\tilde{I}$ represents the physical impact of the firm's activities on the natural world, $\tilde{S}_t$ is a cash flow that is driven by the stakeholders' expectations of $\tilde{I}$. $p$ parsimoniously captures how the stakeholders' expectations materialise in additional financial benefits or costs. $p > 0$ ensures that

[3] Assuming $c(q, s) = \frac{(s+q)^2}{2}$ would require further parameter restrictions and assumptions for both $q > 0$ and $s > 0$ to hold in equilibrium. Alternatively, costs could be linear $c(q, s) = q + s + \tilde{\gamma}$, whilst financial benefits concave in investments (e.g. $\tilde{R} = \sqrt{q}\theta + \tilde{r}$). These alternative assumptions do not qualitatively alter results, but the equilibrium investments become longer mathematical expressions. Since $c(q, s) = \frac{q^2}{2} + \frac{s^2}{2}$ most parsimoniously captures the model's insights, I use this specification.

[4] Appendix B discusses the setting where both $q$ and $s$ induce positive environmental externalities.

expectations of a positive $E[\tilde{I}|\Phi^{ST}_{t-k}] > 0$ or a negative $E[\tilde{I}|\Phi^{ST}_{t-k}] < 0$ environmental impact translate into additional financial benefits $\tilde{S}_t > 0$ and costs $\tilde{S}_t < 0$, respectively. If a given $E[\tilde{I}|\Phi^{ST}_{t-k}]$ induces a lot of stakeholder pressure and financial outcomes are very sensitive to this pressure, $p$ is higher (vice versa).[5] $\tilde{S}_t$ at $t$ is affected by information that is available to stakeholder prior to $t$ at $t-k$ (i.e. $\Phi^{ST}_{t-k}$). Unlike stock prices that instantly react to information, any action of stakeholders based on information that becomes public at $t$ will likely be too late to affect the financial outcome at $t$. For example, an environmental scandal that becomes public at $t$ potentially leads to public outrage and adversely affects consumer demand. However, $\tilde{S}_t$ is the result of consumer demand from the beginning of the fiscal year until $t$. Although the exact duration between $t$ and $t-k$ is arbitrary, it is critical that information is available sufficiently early such that the resulting actions of stakeholders who observe it are reflected in the financial performance at $t$.

Combining both the direct and indirect effect of $q$ and $s$ yields the firm's short- ($t = 1$) and long-run ($t = 2$) financial performance, which are denoted with $\tilde{x}_1$ and $\tilde{x}_2$:

$$\tilde{x}_1 = \underbrace{\tilde{R} - \tilde{C}}_{\text{Direct Effect}} + \underbrace{\tilde{S}_1}_{\text{Indirect Effect}} \tag{6}$$

$$\tilde{x}_2 = \underbrace{\tilde{R} + \tilde{B}_s}_{\text{Direct Effect}} + \underbrace{\tilde{S}_2}_{\text{Indirect Effect}} \tag{7}$$

The random components of $\tilde{R}$, $\tilde{C}$, $\tilde{B}_s$, and $\tilde{S}_t$, i.e. $\tilde{r}$, $\tilde{\eta}$, $\tilde{\gamma}$, and $\tilde{i}$ are independent of one another and all follow the normal distribution. Moreover, $\theta, b_s, \beta_q, \beta_s$, and $p$ represent strictly positive parameters that are common knowledge.[6] Information asymmetry stems from the fact that stakeholders and investors cannot directly observe the manager's decisions of $q$ and $s$, which generate environmental externalities and affect financial performance. The presence of $\tilde{R}$ in both $\tilde{x}_1$ and $\tilde{x}_2$ implies the main business activity has direct financial benefits in both short- and long-run, and $\tilde{x}_1$ is informative about $\tilde{x}_2$. However, knowledge of $\tilde{x}_1$ does never fully reveal $\tilde{x}_2$ because $\tilde{C}$ and $\tilde{B}_s$ generate randomness that is idiosyncratic to short- and long-run financial performance, respectively. It follows that $Cov(\tilde{x}_1, \tilde{x}_2) > 0$ but $Cov(\tilde{x}_1, \tilde{x}_2) \neq 1$. Moreover, sustainability investments increase

[5] Instead of $p$, which concerns the net effect of $E[\tilde{I}|\Phi^{ST}_{t-k}]$ on financial performance, one could separately model how $E[\tilde{I}|\Phi^{ST}_{t-k}]$ affects stakeholder pressure and subsequently how stakeholder pressure affects financial performance. However, for the purpose of this paper, this would needlessly complicate the analysis by introducing additional parameters that are implicitly subsumed in $p$. $p \leq \frac{\theta}{2\beta_q}$ implies $q$ is strictly non-negative in equilibrium.

[6] Similarly, the investments' profitability is common knowledge in Kanodia et al. (2004). Kanodia and Lee (1998) relax this assumption. I refrain from discounting long-run financial performance because doing so does not change the effects of mandatory ESG disclosure, albeit simplifies mathematical expressions. Indeed, discounting is comparable to increasing $\alpha$ in equation 8 below.

costs in the short-run to be more sustainable and to gain direct financial benefits particularly in the long-run (through $\tilde{B}_s$). Indirect financial benefits (costs) of $s$ ($q$) based on the stakeholder's expectation of ESG performance affect both short- and long-run financial performance.

## 3.2 The Manager's Utility

Following Stein (1989), the manager's utility increases with $\tilde{x}_1$ and $\tilde{x}_2$, as well as with the stock price $\tilde{P}_1$ at $t = 1$. This stock price contributes to utility because there is a share $\alpha \in (0, 1)$ of "impatient" investors that sell their stocks in the short-run. These investors are interested in a high stock price at $t = 1$, thereby creating stock market pressure that motivates the manager to take actions that increase $\tilde{P}_1$. Compensation schemes, anticipation of a tender offer, or plans to raise equity are further examples why a higher stock price elevates the manager's utility. At $t = 0$, the manager hence chooses $q$ and $s$ to maximize the following expected utility function:

$$\max_{\mathbf{q},\mathbf{s}} \; E[U_0|\Phi_0^{\mathrm{M}}] = E[\tilde{x}_1|\Phi_0^{\mathrm{M}}] + \alpha E[\tilde{P}_1|\Phi_0^{\mathrm{M}}] + (1-\alpha)E[\tilde{x}_2|\Phi_0^{\mathrm{M}}] \tag{8}$$

$E[\tilde{x}_1|\Phi_0^{\mathrm{M}}]$ and $E[\tilde{x}_2|\Phi_0^{\mathrm{M}}]$ denote the manager's expectation of short- and long-run financial performance given the information set $\Phi_0^{\mathrm{M}}$ at $t = 0$. Both the manager and investors are risk-neutral and do not have an altruistic preference for strong environmental performance. However, they care about the firm's environmental impact because of its indirect effect on revenues and costs through stakeholder pressure.[7] $\tilde{P}_1$ equals the investors' expectation of future financial performance conditional on their information set $\Phi_1^I$ at $t = 1$.:

$$\tilde{P}_1 = E[\tilde{x}_2|\Phi_1^{\mathrm{I}}] \tag{9}$$

Proceeds from short-run financial performance $\tilde{x}_1$ are immediately distributed as dividends and $\tilde{P}_1$ represents the post-payout market price.[8] When investors establish $\tilde{P}_1 = E[\tilde{x}_2|\Phi_1^{\mathrm{I}}]$, they form higher-order expectations. The reason is that (part of) $\tilde{x}_2$ depends on expectations of stakeholders. That is, $\tilde{P}_1 = E[\tilde{x}_2|\Phi_1^{\mathrm{I}}] = E[\tilde{R}+\tilde{B}_s+\tilde{S}_2|\Phi_1^{\mathrm{I}}]$, whereby $E[\tilde{S}_2|\Phi_1^{\mathrm{I}}]$ are second-order expectations equal to $pE[E[\tilde{I}|\Phi_1^{ST}]|\Phi_1^{\mathrm{I}}]$. Moreover, at $t = 0$ the manager's expectation of $\tilde{P}_1$ consists of both second-

[7]Findings are not altered if the manager or investors have altruistic preferences for strong environmental performance, but the equilibrium values of $s$ and $q$ are larger and smaller, respectively. These cases are studied in Appendix B.

[8]Alternatively, $\tilde{P}_1$ could be defined as $\tilde{P}_1 = \tilde{x}_1 + E[\tilde{x}_2|\Phi_1^{\mathrm{I}}]$ and $\tilde{P}_2 = \tilde{x}_1 + \tilde{x}_2$. Under these assumptions, the expected utility function $E[U_0|\Phi_0^{\mathrm{M}}] = \alpha E[\tilde{P}_1|\Phi_0^{\mathrm{M}}] + (1-\alpha)E[\tilde{P}_2|\Phi_0^{\mathrm{M}}]$ is equivalent to equation 8 with $\tilde{P}_1 = E[\tilde{x}_2|\Phi_1^{\mathrm{I}}]$. This alternative notation is used in Kanodia and Sapra (2016) and leads to the same results as Stein's (1989) notation.

order and third-order expectations: $E[\tilde{P}_1|\Phi_0^{\mathrm{M}}] = E[E[\tilde{R} + \tilde{B}_s|\Phi_1^{\mathrm{I}}]|\Phi_0^{\mathrm{M}}] + pE[E[E[\tilde{I}|\Phi_1^{ST}]|\Phi_1^{\mathrm{I}}]|\Phi_0^{\mathrm{M}}]$. Spelled out, $E[E[E[\tilde{I}|\Phi_1^{ST}]|\Phi_1^{\mathrm{I}}]|\Phi_0^{\mathrm{M}}]$ is the manager's expectation at $t = 0$ (when $q$ and $s$ is chosen) of the investors' expectations at $t = 1$ (when the stock price is formed) of the non-investor stakeholders' expectations of $\tilde{I}$ at $t = 1$. The investors care about the ESG-interested stakeholders' expectations because they influence (through their financial pressure for strong ESG) the long-run financial performance $\tilde{x}_2$. The manager is interested in the investors' expectations because they determine the stock price, which subsequently affects utility. In a similar vein, $E[\tilde{x}_1|\Phi_0^{\mathrm{M}}]$ and $E[\tilde{x}_2|\Phi_0^{\mathrm{M}}]$ are partly second-order expectations as $E[\tilde{I}|\Phi_{t-k}^{ST}]$ influences $\tilde{x}_1$ and $\tilde{x}_2$. Figure 1 below demonstrates the relation between the manager, ESG-interested stakeholders, and investors as captured in the model.

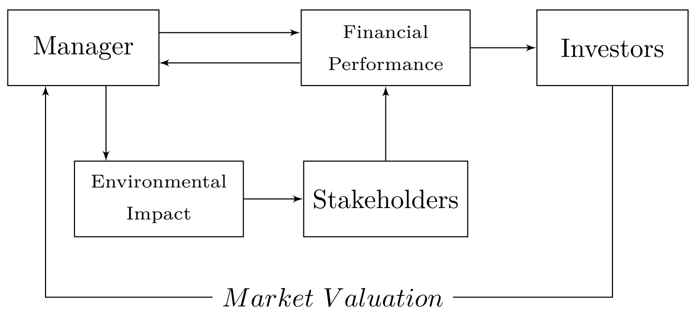



Figure 1: Causal Relation Between Manager, Stakeholders, and Investors

Since changes in the information contained in $\Phi^{\mathrm{M}}$, $\Phi^{\mathrm{I}}$ and $\Phi^{\mathrm{ST}}$ alter the players' expectations, they affect financial performance, the stock price, and subsequently matter for the manager's utility.

### 3.3 Information Endowments

Although $q$ and $s$ are private to the manager, I assume the short-run financial performance $\tilde{x}_1$ is published at $t = 1$. Since $Cov(\tilde{x}_1, \tilde{x}_2) > 0$, investors who observe a high $\tilde{x}_1$ conclude that $\tilde{x}_2$ is likely high too, which subsequently boosts $\tilde{P}_1 = E[\tilde{x}_2|\Phi_1^{\mathrm{I}} = \{\tilde{x}_1\}]$ and according to equation 8 translates into higher utility. Managers thus have an incentive to engage in actions that inflate $\tilde{x}_1$.[9] In the absence of asymmetric information and impatient investors, actions to boost $\tilde{x}_1$ in an attempt to influence $\tilde{P}_1$ are not fruitful. Without impatient investors, $\alpha$ is zero and equation 8 simplifies to $U_0 = E[\tilde{x}_1|\Phi_0^{\mathrm{M}}] + E[\tilde{x}_2|\Phi_0^{\mathrm{M}}]$. Moreover, without asymmetric information, inflating $\tilde{x}_1$

[9]This (inefficient) short-run focus has been referred to as *managerial* myopia, albeit the underlying cause for short-termism are frequently impatient investors rather than an inherently short-run oriented manager (Wagenhofer, 2014). See e.g. Laverty, (1996) for a review on economic short-termism.

to increase $E[\tilde{x}_2|\Phi_1^{\mathrm{I}}]$, i.e. "jamming the signal" that investors observe, is a wasteful action. This result occurs because if $\Phi_1^{\mathrm{I}} = \Phi_0^{\mathrm{M}}$, by the law of iterated expectations, $E[E[\tilde{x}_2|\Phi_1^{\mathrm{I}}]|\Phi_0^{\mathrm{M}}] = E[\tilde{x}_2|\Phi_0^{\mathrm{M}}]$ holds. Equation 8, again, simplifies to $U_0 = E[\tilde{x}_1|\Phi_0^{\mathrm{M}}] + E[\tilde{x}_2|\Phi_0^{\mathrm{M}}]$ and there is no incentive for the manager to inflate $\tilde{x}_1$ to boost $\tilde{P}_1$.

Information asymmetry between the players could concern financial ($\tilde{x}_1$ and $\tilde{x}_2$) as well as nonfinancial outcomes ($\tilde{I}$). In most settings below, I assume there is an imprecise signal about $\tilde{I}$, i.e. $\tilde{y}$, at $t = 0.5$:

$$\tilde{y} = \tilde{I} + \tilde{\varepsilon} = \beta_s s - \beta_q q + \tilde{i} + \tilde{\varepsilon} \tag{10}$$

where $\tilde{\varepsilon}$ is independent of $\tilde{r}$, $\tilde{\eta}$, $\tilde{\gamma}$, $\tilde{i}$ and $\tilde{\varepsilon} \sim N(0, \sigma^2_{\tilde{\varepsilon}})$. If $\tilde{I}$ is not disclosed, stakeholders cannot distinguish the noise $\tilde{\varepsilon}$ from $\tilde{i}$ after observing $\tilde{y}$. The signal $\tilde{y}$ could (initially) be private information of non-investor stakeholders. For example, NGOs such as the Environmental Investigation Agency specialise in acquisition of ESG information. Moreover, $\tilde{y}$ could be observed by firm-internal stakeholders such as employees. Alternatively, the signal $\tilde{y}$ could come from a public source such as an ESG rating agency, a government database, or media. On the one hand, if $\tilde{y}$ is public at $t = 0.5$, investors likely also know $\tilde{y}$ when they form their expectations at $t = 1$. On the other hand, even if public information underlies stakeholder pressure for strong ESG performance, when there are multiple information sources investors may be uncertain of the exact information that shapes the expectations of non-investor stakeholders. I both examine settings where investors observe and where they do not observe $\tilde{y}$.

When the manager chooses $q$ and $s$ at $t = 0$, the signal $\tilde{y}$ is unknown because it becomes public later at $t = 0.5$. Put differently, the manager can anticipate e.g. media reports when taking decisions that generate externalities, but at $t = 0$ the manager does not know the report that is published in the future.[10] Furthermore, I consider both the situation when the firm discloses its true environmental impact $\tilde{I}$ at $t = 1$, or not. The model captures the stakeholder, stock price, and signal-jamming effects of disclosing $\tilde{I}$ as outlined below:

(i) More precise information on $\tilde{I}$ means $E[\tilde{I}|\Phi^{ST}_{t-k}]$ better reflects $\tilde{I}$. I will demonstrate that if the information about $\tilde{I}$ is less noisy, the stakeholders' expectations are more sensitive to

[10]The arrival of $\tilde{y}$ post the management decisions but prior to the market valuation is similar to the timing of the forecast $\tilde{s}$ in Kanodia and Mukherji (1996). A critical difference between $\tilde{s}$ in Kanodia and Mukherji (1996) and $\tilde{y}$ in my model is that $\tilde{s}$ only affects the market valuation, but $\tilde{y}$ additionally (through $\tilde{S}_t$) directly affects financial performance $\tilde{x}_t$.

this information.[11] If $E[\tilde{I}|\Phi^{ST}_{t-k}]$ closely reflects the true environmental impact and is very responsive to it, the financial benefits and manager's utility of actions that enhance $\tilde{I}$ grow. The reasons is that any improvement in $\tilde{I}$ leads to a larger increase in $E[\tilde{I}|\Phi^{ST}_{t-k}]$, subsequently to better financial performance through $\tilde{S}_t$, and thus elevates the manager's utility (ceteris paribus).

(ii) Post disclosure of $\tilde{I}$, the stock price increases for a given improvement in $\tilde{I}$ to a larger extent. The reason is that $\tilde{P}_1$ reacts positively to strong financial performance $\tilde{x}_2$ and, according to the stakeholder affect above, $\tilde{S}_2$ and thus $\tilde{x}_2$ is higher for a given boost in $\tilde{I}$ if there is more precise information about $\tilde{I}$.

(iii) Finally, disclosing $\tilde{I}$ at $t = 1$ changes $\tilde{S}_t$ from $\tilde{S}_1 = pE[\tilde{I}|y]$ to $\tilde{S}_2 = pE[\tilde{I}|I] = pI$. Unlike $\tilde{x}_2$, $\tilde{x}_1$ is through $\tilde{S}_1$ affected by the noise in $\tilde{y}$ (i.e. $\tilde{\varepsilon}$), implying that $\tilde{x}_1$ becomes a nosier signal for $\tilde{x}_2$ (without disclosure, $\tilde{S}_2 = \tilde{S}_1 = pE[\tilde{I}|y]$). Moreover, beyond $\tilde{x}_1$, investors have an additional information source to predict $\tilde{S}_2$ if $\tilde{I}$ is disclosed. As a result, investors put a lower weight on $\tilde{x}_1$ when forming their expectations $\tilde{P}_1 = E[\tilde{x}_2|\Phi^{\mathrm{I}}_1]$. This reduction in the stock price's sensitivity to $\tilde{x}_1$ reduces incentives to "jam" $\tilde{x}_1$, mitigates managerial myopia, and changes investment decisions irrespectively of their environmental impact.

Although effects (i)-(ii) motivate the manager to enhance $\tilde{I}$, effect (iii) can worsen ESG performance. It is thus, a priori, unclear whether mandatory disclosure of $\tilde{I}$ improves the firm's environmental impact.

Figure 2 below summarises the sequence of events in the model. At $t = 0$, the manager chooses $q$ and $s$ to maximize utility. These decisions produce financial outcomes $\tilde{x}_1$ and $\tilde{x}_2$ at $t = 1$ and $t = 2$, respectively, together with an environmental impact $\tilde{I}$ that realizes at $t = 1$. Between $t = 0$ and $t = 1$, stakeholders form expectations about $\tilde{I}$ based on $\tilde{y}$. These expectations affect $\tilde{x}_1$ (through $\tilde{S}_1$). At $t = 1$, $\tilde{x}_1$ realizes and gets published. Investors use $\tilde{x}_1$ together with other signals (i.e. $\tilde{y}$ or $\tilde{I}$ if available) to value the firm and to form expectations of $\tilde{x}_2$ which result in the market price $\tilde{P}_1$. If $\tilde{I}$ is published at $t = 1$, stakeholders revise their expectations of $\tilde{I}$ and $E[\tilde{I}|\Phi^{ST}_{0.5}] \neq E[\tilde{I}|\Phi^{ST}_1]$. As a result, $\tilde{S}_1 \neq \tilde{S}_2$ and stakeholder pressure differently influences $\tilde{x}_1$ and $\tilde{x}_2$. If $\tilde{I}$ is not published, $E[\tilde{I}|\Phi^{ST}_{0.5}] = E[\tilde{I}|\Phi^{ST}_1]$, and the effect of stakeholder pressure on short- and long-run financial performance is the same.

[11] This sensitivity is similar to the stock price's sensitivity to financial information in e.g. Fisher and Verrecchia (2000) or Ewert and Wagenhofer (2005).

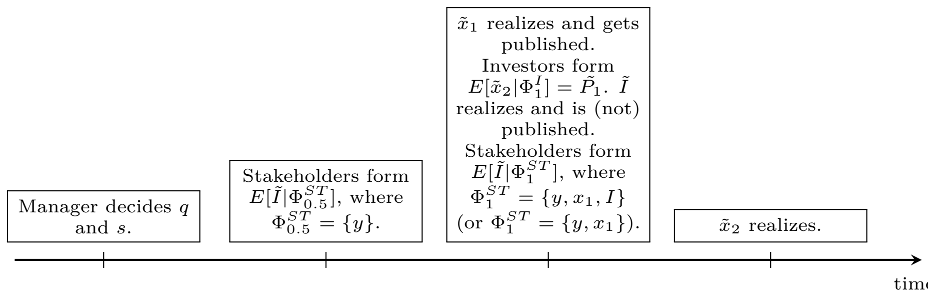



Figure 2: Sequence of Events

# 4 Analysis

Section 4 applies the model to examine how the equilibrium investments in sustainability $s$ and in the main business activity $q$, and thus financial and nonfinancial performance, vary with changes in the players' information sets. Section 4.1 analyzes how management decisions differ when ESG-interested stakeholders have the same information set as the manager compared to when they do not have any information about $\tilde{I}$. In both settings, investors continue to have perfect information of $q$ and $s$. Whilst these settings are unrealistic, section 4.1 studies the effect of changes in the information set of ESG-interested stakeholders absent of any changes in signal-jamming incentives that confound results. Section 4.2 examines the effect of information asymmetry between investors and the manager when there is no ESG-information (4.2.1), or when there is a signal $\tilde{y}$ that provides imprecise information about $\tilde{I}$ at $t = 0.5$ (4.2.2). Finally, section 4.3 analyzes the full model with signal $\tilde{y}$ at $t = 0.5$, corporate disclosure of the true $\tilde{I}$ at $t = 1$, as well as information asymmetry between the manager, investors, and ESG-interested stakeholders. Section 4 concludes with a discussion on value relevance and implications for empirical research.

## 4.1 Settings Without Signal-Jamming Incentives

### 4.1.1 All Players Observe Management Decisions

In this section, not only the manager but also investors and non-investor stakeholders observe $q$ and $s$. That is, firm-external parties know at least the same information as the manager at $t = 0$, or equivalently $\Phi_0^M = \{q, s\} \subseteq \Phi_{0.5}^{ST} \subseteq \Phi_1^I \subseteq \Phi_1^{ST}$. Using basic properties of conditional expectations and the law of iterated expectations, I evaluate the different components of the manager's utility $U_0 = E[\tilde{x}_1|\Phi_0^{\mathrm{M}}] + \alpha E[\tilde{P}_1|\Phi_0^{\mathrm{M}}] + (1-\alpha)E[\tilde{x}_2|\Phi_0^{\mathrm{M}}]$. At $t = 0$, the manager's expectations of the short-run and long-run financial performance are:

$$E[\tilde{x}_1|\Phi_0^{\mathrm{M}}] = E[\tilde{R} - \tilde{C} + \tilde{S}_1|\Phi_0^{\mathrm{M}}] = E[\tilde{R} - \tilde{C} + pE[\tilde{I}|\Phi_{0.5}^{\mathrm{ST}}]|\Phi_0^{\mathrm{M}}] =$$
$$\theta q - \frac{q^2}{2} - \frac{s^2}{2} + p(\beta_s s - \beta_q q)$$
and
$$E[\tilde{x}_2|\Phi_0^{\mathrm{M}}] = E[\tilde{R} + \tilde{B}_s + \tilde{S}_2|\Phi_0^{\mathrm{M}}] = E[\tilde{R} + \tilde{B}_s + pE[\tilde{I}|\Phi_1^{\mathrm{ST}}]|\Phi_0^{\mathrm{M}}] =$$
$$\theta q + b_s s + p(\beta_s s - \beta_q q)$$

Moreover, the manager's expectation of the stock price $\tilde{P}_1 = E[\tilde{x}_2|\Phi_1^I]$ is more evolved because it is affected by third-order expectations, but under full information $E[\tilde{P}_1|\Phi_0^{\mathrm{M}}]$ simplifies to:

$$E[\tilde{P}_1|\Phi_0^{\mathrm{M}}] = E[\underbrace{E[\tilde{R} + \tilde{B}_s + pE[\tilde{I}|\Phi_1^{\mathrm{ST}}]|\Phi_1^{\mathrm{I}}]}_{\tilde{P}_1 = E[\tilde{x}_2|\Phi_1^I]}|\Phi_0^{\mathrm{M}}] = E[\tilde{R} + \tilde{B}_s + p(\beta_s s - \beta_q q)|\Phi_0^{\mathrm{M}}] =$$
$$\theta q + b_s s + p(\beta_s s - \beta_q q)$$

Since $E[\tilde{P}_1|\Phi_0^{\mathrm{M}}] = E[\tilde{x}_2|\Phi_0^{\mathrm{M}}]$, the manager's utility collapses to $U_0 = E[\tilde{x}_1|\Phi_0^{\mathrm{M}}] + E[\tilde{x}_2|\Phi_0^{\mathrm{M}}]$ when there is no asymmetric information. Substituting the above results for $E[\tilde{x}_1|\Phi_0^{\mathrm{M}}]$ and $E[\tilde{x}_2|\Phi_0^{\mathrm{M}}]$ into $U_0$ and taking the first-order condition with respect to $s$ and $q$ yields:

**PROPOSITION 1.** *If the manager's choices of $s$ and $q$ are observed by all players, the equilibrium investments are:* $s_1^* = b_s + 2p\beta_s$ *and* $q_1^* = 2\theta - 2p\beta_q$.

Comparative statics show the optimal quantities of both $s$ and $q$ increase in their direct financial benefits $b_s$ and $2\theta$. Moreover, because $q$ ($s$) has a negative (positive) environmental impact, and ESG-interested stakeholders financially reward strong ESG performance, the manager decreases $q$ by $2p\beta_q$ (increases $s$ by $2p\beta_s$). This adaption of management decisions is particularly pronounced if the respective marginal effects of $q$ and $s$ on $\tilde{I}$, i.e. $\beta_s$ and $\beta_q$, or if the overall influence of ESG-interested stakeholders on the firm's financial performance, i.e. $p$, are large.

#### 4.1.2 Stakeholders Do Not Observe Management Decisions nor ESG Information

If ESG-interested stakeholders do not observe $q$ nor $s$, their expectation of the firm's environmental impact $E[\tilde{I}|\Phi_{t-k}^{ST}]$ is based on conjectures of the manager's decisions. Given these conjectures and since there is no other information about $\tilde{I}$, from the manager's and investors' perspectives the stakeholders' expectations of $\tilde{I}$ are constant and equal to $E[\tilde{I}|\Phi_{0.5}^{ST}] = E[\tilde{I}|\Phi_1^{ST}] = \beta_s \hat{s} - \beta_q \hat{q}$, where $\hat{s}$ and $\hat{q}$ denote conjectures. It follows that $\hat{S}_1 = \hat{S}_2 = p(\beta_s \hat{s} - \beta_q \hat{q})$ does not vary with the manager's choices when ESG-interested stakeholders do not observe $q$ and $s$.[12] The financial outcomes are hence $\tilde{x}_1 = \tilde{R} - \tilde{C} + \hat{S}_1$ and $\tilde{x}_2 = \tilde{R} + \tilde{B}_s + \hat{S}_2$, leading to:

$$E[\tilde{x}_1|\Phi_0^{\mathrm{M}}] = \theta q - \frac{q^2}{2} - \frac{s^2}{2} + \hat{S}_1 \quad \text{and} \quad E[\tilde{x}_2|\Phi_0^{\mathrm{M}}] = \theta q + b_s s + \hat{S}_2$$

Moreover, if $\Phi_0^M = \{q, s\} \subseteq \Phi_1^I$, the manager believes the firm is priced in the stock market with:

$$E[\tilde{P}_1|\Phi_0^{\mathrm{M}}] = E[E[\tilde{R} + \tilde{B}_s + \hat{S}_2|\Phi_1^{\mathrm{I}}]|\Phi_0^{\mathrm{M}}] = E[\tilde{R} + \tilde{B}_s + \hat{S}_2|\Phi_0^{\mathrm{M}}] = \theta q + b_s s + \hat{S}_2$$

$E[\tilde{P}_1|\Phi_0^{\mathrm{M}}] = E[\tilde{x}_2|\Phi_0^{\mathrm{M}}]$ and $U_0 = E[\tilde{x}_1|\Phi_0^{\mathrm{M}}] + E[\tilde{x}_2|\Phi_0^{\mathrm{M}}]$ hold because $q$ and $s$ are contained in the investors' information set. The manager's utility maximisation problem shows:

**PROPOSITION 2.** *Stakeholder pressure for strong ESG performance does not influence the manager's equilibrium decisions if stakeholders do not observe (information about) $s$, $q$, and $\tilde{I}$. Moreover, when $\Phi_0^M = \{q, s\} \subseteq \Phi_1^I$, these equilibrium decisions are $s_2^* = b_s$ and $q_2^* = 2\theta$.*

If no information on the firm's environmental impact is communicated to ESG-interested stakeholders, any improvement in environmental performance does not change the stakeholders' expectations of $\tilde{I}$ and there is no additional financial benefit to this improvement. That is, $\hat{S}_1 = \hat{S}_2$ is constant regardless of the realization of $\tilde{I}$. In contrast to section 4.1.1 where stakeholders observe relevant information about $\tilde{I}$, $s_2^*$ and $q_2^*$ thus do not adapt to stakeholder pressure for strong ESG performance. Even if stakeholders had perfect information about $\tilde{I}$, the same result occurs when $p = 0$, i.e. when stakeholders do not have any (ESG-related) influence on $\tilde{x}_1$ and $\tilde{x}_2$. Comparing the equilibrium investments under Proposition 1 and 2, it is obvious that if there is no information about $\tilde{I}$ the optimal value of $q$ is higher, whilst the optimal level of $s$ is smaller. Ceteris paribus, the expected positive environmental impact $E[\tilde{I}] = \beta_s s - \beta_q q$ is higher when there is information about $\tilde{I}$. However, below I show more information about $\tilde{I}$ does not always improve ESG performance.

[12] See Bagwell (1995), Kanodia and Mukherji (1996), or Kanodia et al. (2004) for further related discussion. If the equilibrium choices of $q$ and $s$ depend on parameters that are known by stakeholders, this verifies that they can indeed make these conjectures. The same applies to the investors' conjectures below. In the rational expectation equilibrium, the stakeholders' and investors' conjectures coincide and equal the actual choices of the manager.

The equilibrium investments of Proposition 1 and 2 should be interpreted bearing in mind that they are based on the stark assumption that investors have the same information as the manager.

## 4.2 Information Asymmetry Between All Players and No ESG Disclosure

### 4.2.1 Financial Disclosure But No ESG Information

In a more realistic setting, investors and other stakeholders do not perfectly observe $q$ and $s$ but the firm reports $\tilde{x}_1$ at $t = 1$. For now, I continue to assume that there is no information of $\tilde{I}$. The only public signal $\tilde{x}_1$ does not provide any information about $\tilde{I}$ because the independence assumptions of the random variables imply $Cov(\tilde{r}, \tilde{I}) = Cov(\tilde{\gamma}, \tilde{I}) = 0$. The manager's expectations of $\tilde{x}_1$ and $\tilde{x}_2$ are, therefore, the same as in section 4.1.2 and equal $E[\tilde{x}_1|\Phi_0^{\mathrm{M}}] = \theta q - \frac{q^2}{2} - \frac{s^2}{2} + \hat{S}_1$ and $E[\tilde{x}_2|\Phi_0^{\mathrm{M}}] = \theta q + b_s s + \hat{S}_2$, where $\hat{S}_1$ and $\hat{S}_2$ are constants because of the stakeholders' conjectures of $\hat{q}$ and $\hat{s}$. The manager cares about the market price at $t = 1$ and needs to form the conditional expectation $E[\tilde{P}_1|\Phi_0^M]$. Since $\Phi_0^M \subseteq \Phi_1^I$ no longer holds if investors do not know $q$ and $s$, the law of iterated expectations fails and $E[\tilde{P}_1|\Phi_0^M] = E[E[\tilde{x}_2|\Phi_1^{\mathrm{I}}]|\Phi_0^M] \neq E[\tilde{x}_2|\Phi_0^{\mathrm{M}}]$. To evaluate the manager's expectation of the stock price, I first establish $\tilde{P}_1 = E[\tilde{x}_2|\Phi_1^{\mathrm{I}}]$. When investors form expectations about $\tilde{x}_2$ at $t = 1$, the only information available to them is $\tilde{x}_1$. That is, $\Phi_1^{\mathrm{I}} = \{x_1\}$. The manager's choices of $q$ and $s$ determine both $\tilde{x}_2$ and $\tilde{x}_1$ (through $\tilde{R}, \tilde{C}$, and $\tilde{B}_s$). Since investors do not observe these choices, to form the conditional expectation $\tilde{P}_1 = E[\tilde{x}_2|x_1]$ and similarly to ESG-interested stakeholders, investors need to conjecture the manager's decisions. Given their conjectures, from the perspective of investors the financial outcomes are $\hat{x}_1 = \theta\hat{q} + \tilde{r} - \frac{\hat{q}^2}{2} - \frac{\hat{s}^2}{2} - \tilde{\gamma} + \hat{S}_1$ and $\hat{x}_2 = \theta\hat{q} + \tilde{r} + b_s\hat{s} + \tilde{\eta} + \hat{S}_2$. $\hat{x}_1$ and $\hat{x}_2$ follow the normal distribution because $\tilde{r}$, $\tilde{\gamma}$ and $\tilde{\eta}$ are normally distributed (all other terms are mathematically equivalent to constants). The conditional expectation $\tilde{P}_1 = E[\tilde{x}_2|x_1]$ is given by $E[\hat{x}_2] + \frac{Cov(\tilde{x}_2, \tilde{x}_1)}{Var(\tilde{x}_1)}(x_1 - E[\hat{x}_1])$, which simplifies to:[13]

$$\tilde{P}_1 = E[\tilde{x}_2|x_1] = \hat{\beta}_0 + \hat{\beta}_1 x_1$$

where $\hat{\beta}_0$ and $\hat{\beta}_1$ are constants that equal $\hat{\beta}_0 = E[\hat{x}_2] - \hat{\beta}_1 E[\hat{x}_1]$ and $\hat{\beta}_1 = \frac{\sigma_{\tilde{r}}^2}{\sigma_{\tilde{r}}^2 + \sigma_{\tilde{\gamma}}^2}$. The coefficient $\hat{\beta}_1$ captures the stock price's sensitivity to the disclosure of $\tilde{x}_1$. The manager anticipates that the

[13] Here $Cov(\tilde{x}_2, \tilde{x}_1) = \sigma_{\tilde{r}}^2$ and $Var(\tilde{x}_1) = \sigma_{\tilde{r}}^2 + \sigma_{\tilde{\gamma}}^2$. Throughout the paper, I calculate the conditional expectation with normal variables using the projection theorem, which states: $\boldsymbol{\mu_{x|y} = \mu_x + \sum_{xy} \sum_y^{-1} (y - \mu_y)}$, where $\mu_x$ and $\mu_y$ are unconditional expectations of $x$ and $y$, $\sum_{xy}$ is the vector of covariances between $x$ and the signals $y$, $\sum_y^{-1}$ is the inverse of the matrix of the covariances of signals $y$, and $\mu_{x|y}$ is the conditional expectation of interest.

firm is priced in the market with $\tilde{P}_1$ defined as above. Since $E[\hat{x}_2]$ and $E[\hat{x}_1]$ are constants because of the investors' conjectures and $E[\tilde{r}] = E[\tilde{\eta}] = 0$, the only term in $\tilde{P}_1$ that varies with the decision of $q$ and $s$ is $\hat{\beta}_1 x_1$. It follows that:

$$E[\tilde{P}_1|\Phi_0^{\mathrm{M}}] = \hat{\beta}_0 + \hat{\beta}_1 \underbrace{(\theta q - \frac{q^2}{2} - \frac{s^2}{2} + \hat{S}_1)}_{E[x_1|\Phi_0^{\mathrm{M}}]}$$

Taking the first-order conditions of $U_0$ with respect to $s$ and $q$ yields:

**PROPOSITION 3.** *If financial performance $\tilde{x}_1$ is disclosed at $t = 1$, but neither investors nor non-investor stakeholders observe $s$, $q$, and $\tilde{I}$, the equilibrium investments are: $s_3^* = \frac{b_s(1-\alpha)}{1+\alpha\hat{\beta}_1}$ and $q_3^* = \frac{\theta(2-\alpha+\alpha\hat{\beta}_1)}{1+\alpha\hat{\beta}_1}$.*

If investors only observe $\tilde{x}_1$ instead of $q$ and $s$, both $q^*$ and $s^*$ decline. The greater $\alpha$, the smaller are $q^*$ and $s^*$ because signal-jamming incentives increase: If more shareholders are impatient, $\alpha E[\tilde{P}_1|\Phi_0^M]$ takes a more prominent role in the manager's utility function. Since $\tilde{P}_1 = E[\tilde{x}_2|x_1] = \hat{\beta}_0 + \hat{\beta}_1 x_1$ increases if $\tilde{x}_1$ is higher, the manager has a greater motivation to produce a strong $\tilde{x}_1$ if $\alpha$ goes up. Higher short-run results are obtained through a reduction in $q^*$ and $s^*$ because their costs are incurred in the short-run. Whilst under-investment is a common result in models of hidden action, a particular concern is how this under-investment affects the firm's nonfinancial performance. Reducing $q$ improves, but lowering $s$ is detrimental to the environment. It is, therefore, ambiguous whether information asymmetry between investors and the manager causes a net enhancement in environmental performance. However, it can be shown that:

**COROLLARY 1.** *If there is no information about $\tilde{I}$, in equilibrium the expected (positive) environmental impact $E[\tilde{I}] = \beta_s s^* - \beta_q q^*$ is greater when $\Phi_1^I = \{x_1\}$ compared to when $\Phi_1^I = \Phi_0^M = \{q, s\}$ iff $\beta_q \theta > \beta_s b_s$. Moreover, the expected, direct financial performance is better in the short-run, worse in the long-run, and overall worse when $\Phi_1^I = \{x_1\}$ rather than $\Phi_1^I = \{q, s\}$.*[14]

[14]The proofs of all corollaries are detailed in the Appendix. In assessing the equilibrium nonfinancial and financial performance, expectations are taken from the perspective of date $t = 0$ throughout the paper. I focus here on the direct rather than the direct *and* indirect financial performance to highlight the change in signal-jamming incentives. When ESG-interested stakeholders have no information about $\tilde{I}$, the indirect financial benefit is constant and managers cannot boost $\tilde{x}_1$ through raising $\hat{S}_1$.

If $\beta_q > \beta_s$, the benefit of reducing $q$ by one unit exceeds the negative consequences of lowering $s$ by one unit. Decreasing $q$ and $s$ by equal amounts thus betters environmental performance if $\beta_q > \beta_s$ (ceteris paribus). A second concern is whether $q$ or $s$ increases more following a change from $\Phi_1^{\mathrm{I}} = \{x_1\}$ to $\Phi_1^{\mathrm{I}} = \{q, s\}$. Simple algebra confirms $q_2^* - q_3^* > s_2^* - s_3^*$ if $\theta > b_s$, i.e. the change in $q$ surpasses the change in $s$ if $\theta > b_s$. As a result, the environmental damage is greater in case $\Phi_1^{\mathrm{I}} = \{q, s\}$ if $\beta_q\theta > \beta_s b_s$. The direct financial benefit in the short-run (i.e. $\theta q - \frac{q^2}{2} - \frac{s^2}{2}$) is larger in the asymmetric information setting because of signal-jamming incentives to inflate $\tilde{x}_1$ and boost $\tilde{P}_1 = E[\tilde{x}_2|x_1]$. Any deviation from maximizing the total direct financial benefit, e.g. to "jam" the signal that investors observe, is economically inefficient, thus leading the outcome that the overall, direct financial performance worsens with asymmetric information.[15]

The main insights of this section are: Beyond $\beta_q$ and $\beta_s$, the relative sensitivity of $q^*$ and $s^*$ to the players' information sets is critical when comparing ESG performance between various settings. Changing information endowments to elicit reductions in business activities can be detrimental to the environment, especially when managers find it optimal to cut investments in sustainability rather than investments that generate negative externalities. Moreover, although it leads to worse financial performance, if $\beta_q\theta > \beta_s b_s$ non-investor stakeholders interested in strong ESG performance prefer information asymmetry between investors and the manager.

#### 4.2.2 Financial Disclosure and Imprecise ESG Information

In this section, there is imprecise information about $\tilde{I}$ at $t = 0.5$, i.e. $\tilde{y} = \tilde{I} + \tilde{\varepsilon}$ with $\tilde{\varepsilon} \sim N(0, \sigma_{\tilde{\varepsilon}}^2)$. As discussed, $\tilde{y}$ could be known by investors or private to non-investor stakeholders. Regardless of whether $\Phi_1^{\mathrm{I}} = \{x_1\}$ or $\Phi_1^{\mathrm{I}} = \{y, x_1\}$, investors need to form expectations of the stakeholders' expectations of $\tilde{I}$ to be able to value the firm. After observing the signal $\tilde{y}$, at $t = 0.5$ the stakeholders' expectation of the firm's environmental impact is $E[\tilde{I}|\Phi_{0.5}^{ST}] = E[\tilde{I}|y] = E[\hat{I}] + \frac{Cov(\tilde{I},\tilde{y})}{Var(\tilde{y})}(y - E[\hat{y}])$. Given that stakeholders form conjectures $\hat{q}$ and $\hat{s}$, $\tilde{y}$ is normally distributed (because $\tilde{y} = \beta_s\hat{s} - \beta_q\hat{q} + \tilde{i} + \tilde{\varepsilon}$, where both $\tilde{i}$ and $\tilde{\varepsilon}$ are normal variables). It follows that $E[\tilde{I}|\Phi_{0.5}^{ST}] = \hat{z}_0 + \hat{z}y$, with $\hat{z}_0 = E[\hat{I}] - \hat{z}E[\hat{y}]$ and $\hat{z} = \frac{\sigma_{\tilde{i}}^2}{\sigma_{\tilde{i}}^2 + \sigma_{\tilde{\varepsilon}}^2}$. $\hat{z}$ captures the sensitivity of the stakeholders' expectations to $\tilde{y}$, which increases in the precision (i.e. $\frac{1}{\sigma_{\tilde{\varepsilon}}^2}$) of the information. The short-run financial performance is thus given by $\tilde{x}_1 = \tilde{R} - \tilde{C} + \tilde{S}_1$, where $\tilde{S}_1 = p(\hat{z}_0 + \hat{z}y)$. The noise of $\tilde{y}$ (i.e $\tilde{\varepsilon}$) affects the short-run financial performance $\tilde{x}_1$ because $\tilde{S}_1$ depends on $\tilde{y}$. Put differently, if stakeholders form expectations

[15] This result is highlighted in e.g. Stein (1989).

of $\tilde{I}$ based on imprecise information, this imprecision also influences the financial consequences of stakeholder pressure. From the perspective of the manager, $\tilde{y}$ is a random variable and $E[\hat{I}]$ as well as $E[\hat{y}]$ are fixed given the conjectures. Following $\tilde{y}$ at $t = 0.5$, $\tilde{x}_1$ at $t = 1$ is the only additional information available to stakeholders. However, since $Cov(\tilde{r}, \tilde{I}) = Cov(\tilde{\gamma}, \tilde{I}) = 0$, $\tilde{x}_1$ does not contain any new insight about $\tilde{I}$ beyond what stakeholders know from $\tilde{y}$. ESG-interested stakeholders hence cannot incrementally learn about the firm's environmental impact from the financial disclosure and $E[\tilde{I}|\Phi_1^{ST}] = E[\tilde{I}|y, x_1] = E[\tilde{I}|y] = E[\tilde{I}|\Phi_{0.5}^{ST}]$. As a result, $\tilde{x}_2 = \tilde{R} + \tilde{B}_s + \tilde{S}_2$, where $\tilde{S}_2 = \tilde{S}_1 = p(\hat{z}_0 + \hat{z}y)$. Since the stakeholders' expectations have not changed, the same stakeholder effect influences both short- and long-run financial performance. At $t = 0$, the manager's expectations of $\tilde{x}_1$ and $\tilde{x}_2$ are:

$$E[\tilde{x}_1|\Phi_0^M] = \theta q - \frac{q^2}{2} - \frac{s^2}{2} + p(\hat{z}_0 + \hat{z}(\beta_s s - \beta_q q)) \text{ and}$$
$$E[\tilde{x}_2|\Phi_0^M] = \theta q + b_s s + p(\hat{z}_0 + \hat{z}(\beta_s s - \beta_q q))$$

The market's valuation of the firm's long-run financial performance, i.e. $\tilde{P}_1 = E[\tilde{x}_2|\Phi_1^I]$, critically depends on the information set available to investors:

$$\tilde{P}_1 = \hat{\beta}_0^a + \hat{\beta}_1^a x_1 + \hat{\beta}_2^a y \quad \text{if} \quad \Phi_1^{\mathrm{I}} = \{y, x_1\}$$
$$\text{and } \tilde{P}_1 = \hat{\beta}_0^b + \hat{\beta}_1^b x_1 \quad \text{if} \quad \Phi_1^{\mathrm{I}} = \{x_1\}$$

where $\hat{\beta}_1^a = \frac{\sigma_{\tilde{r}}^2}{\sigma_{\tilde{r}}^2 + \sigma_{\tilde{\gamma}}^2} < \hat{\beta}_1^b = \frac{\sigma_{\tilde{r}}^2 + (p\hat{z})^2(\sigma_{\tilde{i}}^2 + \sigma_{\tilde{\varepsilon}}^2)}{\sigma_{\tilde{r}}^2 + \sigma_{\tilde{\gamma}}^2 + (p\hat{z})^2(\sigma_{\tilde{i}}^2 + \sigma_{\tilde{\varepsilon}}^2)}$.[16] If $\Phi_1^{\mathrm{I}} = \{y, x_1\}$, investors can disentangle the randomness of $\tilde{y}$ (i.e. $\tilde{i}$ and $\tilde{\varepsilon}$) from other random variables in $\tilde{x}_1$ (i.e. $\tilde{r}$ and $\tilde{\gamma}$). Investors thus have the same information about the persistent component in financial performance $\tilde{r}$ as in the setting where ESG-interested stakeholders did not observe $\tilde{y}$. Their sensitivity to $\tilde{x}_1$ remains unchanged and equals $\hat{\beta}_1^a = \hat{\beta}_1$. Alternatively, when investors do not know $\tilde{y}$, they cannot remove the effect of $\tilde{i}$ and $\tilde{\varepsilon}$ from $\tilde{x}_1$. Observing only $\tilde{x}_1$ thus provides less precise information about the persistent component $\tilde{r}$ in financial performance. This effect diminishes the investors' sensitivity to $\tilde{x}_1$, as reflected by the term $(p\hat{z})^2(\sigma_{\tilde{i}}^2 + \sigma_{\tilde{\varepsilon}}^2)$ in the denominator of $\hat{\beta}_1^b$. However, since $\tilde{y}$ affects $\tilde{x}_2$, if $\Phi_1^{\mathrm{I}} = \{x_1\}$ investors have to infer $\tilde{y}$ from $\tilde{x}_1$ and the term $(p\hat{z})^2(\sigma_{\tilde{i}}^2 + \sigma_{\tilde{\varepsilon}}^2)$ is also present in the numerator of $\hat{\beta}_1^b$. If $\Phi_1^{\mathrm{I}} = \{x_1\}$, the net result is an increase in the investors' sensitivity to the information $\tilde{x}_1$ (i.e. $\hat{\beta}_1^b > \hat{\beta}_1^a = \hat{\beta}_1$) because $\tilde{y}$, which affects long-run financial performance

[16] $\hat{\beta}_0^a$, $\hat{\beta}_2^a$, and $\hat{\beta}_0^b$ are explicitly stated in the Appendix.

through $\tilde{S}_2$, must be inferred from $\tilde{x}_1$. The signal $\tilde{y}$ does, therefore, not only influence the financial repercussions of stakeholder pressure, but also affects how investors react to information of financial performance. Since $\hat{\beta}_1^b > \hat{\beta}_1^a$, the manager has a greater incentive to engage in signal-jamming and to boost the stock price through inflating $\tilde{x}_1$ when $\Phi_1^{\mathrm{I}} = \{x_1\}$ rather than $\Phi_1^{\mathrm{I}} = \{y, x_1\}$.

When $\gamma = 0$, $\hat{\beta}_1^b = \hat{\beta}_1^a = 1$ holds and these different signal-jamming incentives disappear. In this case, $\Phi_1^{\mathrm{I}} = \{y, x_1\}$ does not provide more information than $\Phi_1^{\mathrm{I}} = \{x_1\}$ for the investors' prediction of $\tilde{x}_2$. The reason is that when $\gamma = 0$, every random component of $\tilde{x}_1$ is present in $\tilde{x}_2$ and whether $\tilde{i}$ and $\tilde{\varepsilon}$ are disentangled from other random variables in $\tilde{x}_1$ does not change the investors' information about $\tilde{x}_2$. Investors would identically value the firm and management decisions are the same when $\Phi_1^{\mathrm{I}} = \{x_1\}$ or $\Phi_1^{\mathrm{I}} = \{y, x_1\}$. In contrast, when $\gamma > 0$ there is a random variable that is idiosyncratic to $\tilde{x}_1$ such that commingling all random variables of $\tilde{x}_1$ entails an informational loss. Similarly, when stakeholders would observe $\tilde{I}$ at $t = 1$, the noise of $\tilde{y}$ (i.e. $\tilde{\varepsilon}$) would only affect $\tilde{x}_1$, but not $\tilde{x}_2$ and commingling all random variables in $\tilde{x}_1$ provides worse information for $\tilde{x}_2$.[17]

Since the stock price only reacts to $\tilde{y}$ if investors indeed observe this information, the manager has additional incentives to improve nonfinancial performance when $\Phi_1^{\mathrm{I}} = \{y, x_1\}$ rather than $\Phi_1^{\mathrm{I}} = \{x_1\}$. $\tilde{x}_1$ is indirectly through $\tilde{S}_1$ affected by $\tilde{y}$, but there is no direct influence of $\tilde{y}$ on $\tilde{P}_1$ when $\Phi_1^{\mathrm{I}} = \{x_1\}$. At $t = 0$, the manager anticipates the market valuation and expects that the firm is priced as follows:

$$E[\tilde{P}_1|\Phi_0^{\mathrm{M}}] = \hat{\beta}_1^a(\theta q - \frac{q^2}{2} - \frac{s^2}{2}) + p\hat{z}(\beta_s s - \beta_q q) + \hat{k}^a \quad \text{if} \quad \Phi_1^{\mathrm{I}} = \{y, x_1\}$$
$$\text{and} \quad E[\tilde{P}_1|\Phi_0^{\mathrm{M}}] = \hat{\beta}_1^b(\theta q - \frac{q^2}{2} - \frac{s^2}{2} + p\hat{z}(\beta_s s - \beta_q q)) + \hat{k}^b \quad \text{if} \quad \Phi_1^{\mathrm{I}} = \{x_1\}$$

where $\hat{k}^a = \hat{\beta}_0^a + p\hat{z}_0\hat{\beta}_1^a$ and $\hat{k}^b = \hat{\beta}_0^b + p\hat{z}_0\hat{\beta}_1^a$. $\hat{k}^a$ and $\hat{k}^b$ are additive constants that do not vary with the manager's choices of $q$ and $s$. Maximizing $U_0$ with respect to $q$ and $s$ yields:

**PROPOSITION 4.** *If ESG-interested stakeholders observe imprecise nonfinancial information $\tilde{y}$ at $t = 0.5$ and financial performance $\tilde{x}_1$ is disclosed at $t = 1$, the equilibrium investments are* $s_{4a}^* = \frac{b_s(1-\alpha)+2p\hat{z}\beta_s}{1+\alpha\hat{\beta}_1^a}$ *and* $q_{4a}^* = \frac{\theta[2-\alpha+\alpha\hat{\beta}_1^a)]-2p\hat{z}\beta_q}{1+\alpha\hat{\beta}_1^a}$ *if* $\Phi_1^I = \{y, x_1\}$, *or* $s_{4b}^* = \frac{b_s(1-\alpha)+p\hat{z}\beta_s[2-\alpha+\alpha\hat{\beta}_1^b)]}{1+\alpha\hat{\beta}_1^b}$ *and* $q_{4b}^* = \frac{\theta(2-\alpha+\alpha\hat{\beta}_1^b)-p\hat{z}\beta_q(2-\alpha+\alpha\hat{\beta}_1^b)}{1+\alpha\hat{\beta}_1^b}$ *if* $\Phi_1^I = \{x_1\}$.

[17] Section 4.3 studies this case in detail.

With the information $\tilde{y}$, the stakeholder effect which financially rewards and punishes high $s$ and $q$, respectively, influences the equilibrium investments (e.g. through $\frac{2p\hat{z}\beta_s}{1+\alpha\hat{\beta}_1^a}$ when $s^* = s_{4a}^*$). The reason is that the manager can communicate environmental improvements to stakeholders through $\tilde{y}$, which boosts $E[\tilde{I}|\Phi^{\mathrm{ST}}]$ and reaps financial rewards. The manager thus finds it optimal to improve $\tilde{I}$ with a higher $s$ and lower $q$. This stakeholder effect increases with the precision (i.e. $\frac{1}{\sigma_{\tilde{\varepsilon}}^2}$) of $\tilde{y}$ because the stakeholders sensitivity to this information $\hat{z}$ increases with $\frac{1}{\sigma_{\tilde{\varepsilon}}^2}$. Moreover, when $\frac{1}{\sigma_{\tilde{\varepsilon}}^2}$ increases, the stakeholders' expectations and financial repercussions thereof (i.e. $\tilde{S}_t = pE[\tilde{I}|\Phi^{ST}]$) reflect $\tilde{I}$ more accurately. If $\Phi_1^{\mathrm{I}} = \{y, x_1\}$, signal-jamming incentives are unchanged because $\hat{\beta}_1^a = \hat{\beta}_1$, and since both the stakeholder effect and the stock price reward a higher $\tilde{y}$, $s_{4a}^* > s_3^*$ and $q_{4a}^* < q_3^*$ holds. As stated in Corollary 2, this growth in sustainability investments and reduction in environmentally harmful activities results in an enhancement of ESG performance.

**COROLLARY 2.** *Equilibrium nonfinancial performance, measured as $E[\tilde{I}] = \beta_s s^* - \beta_q q^*$:*

*(i) is always higher when ESG-interested stakeholders observe $\tilde{y}$ than when they do not observe $\tilde{y}$ if $\Phi_1^I = \{y, x_1\}$.*

*(ii) is higher when ESG-interested stakeholders observe $\tilde{y}$ than when they do not observe $\tilde{y}$ and if $\Phi_1^I = \{x_1\}$ when either a) $\theta\beta_q > b_s\beta_s$ or b) $\theta\beta_q < b_s\beta_s$ and $p > \bar{p}_1$.*[18]

The stakeholder effect is also present when $\Phi_1^{\mathrm{I}} = \{x_1\}$. However, the stock price does not directly reward a higher $\tilde{y}$ and there are larger signal-jamming incentives because $\hat{\beta}_1^b > \hat{\beta}_1^a = \hat{\beta}_1$. The manager thus has greater incentives to focus on boosting $\tilde{x}_1$ through under-investments rather than improving nonfinancial performance. Under-investment in $q^*$ further enhances $\tilde{I}$, but nonfinancial performance declines if the firm predominantly cuts $s^*$. Indeed, when $\Phi_1^{\mathrm{I}} = \{x_1\}$ the stakeholders' observation of $\tilde{y}$ is only environmentally beneficial if either condition of bullet point (ii) in Corollary 2 is satisfied. Condition a) ensures $q^*$ is very sensitive to changes in $\Phi^{\mathrm{ST}}$ and condition b) leads to a high indirect financial benefit of lowering $q^*$ and increasing $s^*$. Both conditions are consistent with environmental improvements when $\Phi_1^{\mathrm{I}} = \{x_1\}$ and $\Phi_{0.5}^{\mathrm{ST}} = \{y\}$ because the manager finds it optimal to predominantly reduce $q^*$ rather than $s^*$. Corollary 2 implies that even if investors do not have an intrinsic preference of strong ESG performance, their information endowment of nonfinancial performance has an important influence on ESG outcomes.

[18] All critical thresholds of $p$ are derived and explicitly stated in the Appendix.

Whilst nonfinancial performance strictly improves when $\Phi_1^{\mathrm{I}} = \{y, x_1\}$, the effect on the firm's profitability is ambiguous. Without the information $\tilde{y}$, the firm under-invested in both $q^*$ and $s^*$ when there is information asymmetry between investors and the manager. With the signal $\tilde{y}$, because $s_{4a}^* > s_3^*$ and $q_{4a}^* < q_3^*$, the under-investment problem is even greater for $q^*$, but mitigated for $s^*$. Corollary 3 suggests that financial performance is better with signal $\tilde{y}$ for all $p > 0$ if the (direct) marginal, financial benefit, i.e. $b_s$, and the marginal environmental benefit of sustainability investments, i.e $\beta_s$, are sufficiently high. A higher $\beta_s$ amplifies the marginal impact of $s$ on $\tilde{I}$, which translates into additional financial benefits because of a higher $S_t$ for a given $s$. When $b_s\beta_s > \theta\beta_q$, the setting with more investment in $s^*$ (and lower $q^*$) is thus financially superior. In contrast, when $b_s\beta_s < \theta\beta_q$ an additional requirement arises to ensure the extent of the stakeholders' influence on financial performance, and thus the indirect financial impact, are sufficiently pronounced. Equations (6) and (7) show that the financial repercussions of the stakeholder effect on short- and long-run financial performance are positive iff $S_t > 0$, whereby $S_t$ increases in $s$ and decreases in $q$ ($\frac{\partial S_t}{\partial s} > 0$ and $\frac{\partial S_t}{\partial q} < 0$). Moreover, from Proposition 4 it is obvious that $s_4^*$ increases in $p$, whilst $q_4^*$ decreases in $p$ ($\frac{\partial s_4^*}{\partial p} > 0$ and $\frac{\partial q_4^*}{\partial p} < 0$). As a result, $S_t > 0$ more likely holds for higher values of $p$ and the setting with a stakeholder effect (and higher $s^*$ and lower $q^*$) is more likely financially superior if $p$ is high. This discussion applies to both $\Phi_1^{\mathrm{I}} = \{y, x_1\}$ and $\Phi_1^{\mathrm{I}} = \{x_1\}$. Bullet point (ii) of Corollary 3 is based on the additional premises that $\theta = b_s$ and $\beta_q = \beta_s$. Beyond improving computational tractability, this assumption allows to better isolate changes in financial performance caused by the different sensitivity of the market price to $\tilde{x}_1$ ($\hat{\beta}_1^a$ vs. $\hat{\beta}_1^b$) when stakeholders observe $\tilde{y}$, or not.[19]

**COROLLARY 3.** *Equilibrium financial performance, measured as $E[FP] = E[\tilde{x}_1^*] + E[\tilde{x}_2^*]$:*

*(i) is higher when ESG-interested stakeholders observe $\tilde{y}$ than when they do not observe $\tilde{y}$ and $\Phi_1^I = \{y, x_1\}$ if a) $\theta\beta_q < b_s\beta_s$ or b) $\theta\beta_q > b_s\beta_s$ and $p > \bar{p}_2$.*

*(ii) is higher when ESG-interested stakeholders observe $\tilde{y}$ than when they do not observe $\tilde{y}$, $\theta = b_s$, $\beta_q = \beta_s$, and $\Phi_1^I = \{x_1\}$ if $p > \bar{p}_3$.*

The optimal balance between economic and environmental welfare drives many policy recommendations that emerge from environmental economics (Kolstad, 2011). This section highlights that if the conditions in Corollary 2 and 3 are satisfied, the information $\tilde{y}$ can simultaneously improve

[19] If this assumption is relaxed, settings with higher $s^*$ ($q^*$) are more likly financially superior if $b_s\beta_s$ ($\theta\beta_q$) is high. For bullet point (i), i.e. when $\Phi_1^{\mathrm{I}} = \{y, x_1\}$, I do not make this assumption because the stock price's sensitivity to $\tilde{x}_1$ is $\hat{\beta}_1^a$ regardless of whether stakeholders observe $\tilde{y}$.

nonfinancial and financial performance and effectively mitigates trade-offs between economic and environmental welfare. Recent empirical studies have addressed this trade-off with a focus on ESG disclosures (e.g. Chen et al., 2018 or Ioannou and Serafeim, 2017). Although most studies point towards an improvement in ESG outcomes following an increase in ESG disclosure, the evidence on financial performance is mixed. For example, Ioannou and Serafeim (2017) find a positive effect on firm value, whilst Chen et al. (2018) show a negative effect of nonfinancial reporting on profitability. Corollary 3 can rationalize these conflicting results and highlights the critical importance of the magnitude of $p$, which gauges the influence of the ESG-interested stakeholders' expectations on financial performance. More broadly, $p$ captures the extent with which the firm internalizes costs of environmental damage (from $q$) and benefits (from $s$). Further analysis shows that $p \geq \bar{p}_2$ and $p \geq \bar{p}_3$ can, depending on the size of other parameters that determine $q^*$, be inconsistent with $q^* > 0$. That is, if ESG-interested stakeholder have a substantial influence over the firm's financial performance, the stakeholders knowledge of $\tilde{y}$ cannot enhance financial performance for any positive investment in the main business activity. This result is in line with empirical studies that find some companies cease production post regulatory changes to increase ESG transparency or relocate plants to avoid reporting on their ESG performance (e.g. Christensen et al., 2017; Rauter, 2020).

### 4.3 Information Asymmetry Between All Players and ESG Disclosure

In this section, there is mandatory disclosure of the true environmental impact $\tilde{I}$ after it realizes at $t = 1$. The stakeholders' information sets are $\Phi_{0.5}^{ST} = \{y\}$ and $\Phi_1^{ST} = \{y, x_1, I\}$. Equivalently to section 4.2.2, since $\Phi_{0.5}^{ST} = \{y\}$ the stakeholders' expectations of $\tilde{I}$ are $E[\tilde{I}|\Phi_{0.5}^{ST}] = \hat{z}_0 + \hat{z}y$ at $t = 0.5$, where $\hat{z}_0 = E[\hat{I}] - \hat{z}E[\hat{y}]$ and $\hat{z} = \frac{\sigma_{\tilde{i}}^2}{\sigma_{\tilde{i}}^2 + \sigma_{\tilde{\varepsilon}}^2}$. Short-run financial performance thus has the same functional form and at $t = 0$ the manager's expectation of $\tilde{x}_1$ is again $E[\tilde{x}_1|\Phi_0^M] = \theta q - \frac{q^2}{2} - \frac{s^2}{2} + p(\hat{z}_0 + \hat{z}(\beta_s s - \beta_q q))$. If the firm's environmental impact is disclosed at $t = 1$, the stakeholders revise their expectations to $E[\tilde{I}|\Phi_1^{ST}] = I$. This revision leads to $\tilde{x}_2 = \tilde{R} + \tilde{B}_s + pI$ and $\tilde{x}_2$, unlike $\tilde{x}_1$, is not affected by $\tilde{y}$ (and hence $\tilde{\varepsilon}$). The absence of $\hat{z}$ from $\tilde{x}_2$ reflects that ESG-interested stakeholders are fully responsive to truthful disclosure of $\tilde{I}$, or equivalently $\hat{z} = 1$. The manager's expectations of $\tilde{x}_2$ equals:

$$E[\tilde{x}_2|\Phi_0^M] = \theta q + b_s s + p(\beta_s s - \beta_q q)$$

Moreover, in the Appendix I show that the stock price equals:

$$\tilde{P}_1 = \hat{\beta}_0^c + \hat{\beta}_1^c x_1 + \hat{\beta}_2^c y + \hat{\beta}_3^c I \text{ if } \Phi_1^I = \{x_1, y, I\}$$
$$\text{and } \tilde{P}_1 = \hat{\beta}_0^d + \hat{\beta}_1^d x_1 + \hat{\beta}_2^d I \text{ if } \Phi_1^I = \{x_1, I\}$$

where $\hat{\beta}_1^c = \hat{\beta}_1^a = \hat{\beta}_1 = \frac{\sigma_{\tilde{r}}^2}{\sigma_{\tilde{r}}^2 + \sigma_{\tilde{\gamma}}^2}$. When investors know $\tilde{y}$, the stock price's sensitivity to $\tilde{x}_1$ and hence signal-jamming incentives remain unchanged. However when investors do not observe $\tilde{y}$, $\hat{\beta}_1^d < \hat{\beta}_1^b$ because $\hat{\beta}_1^d = \frac{\sigma_{\tilde{r}}^2}{\sigma_{\tilde{r}}^2 + \sigma_{\tilde{\gamma}}^2 + (p\hat{z})^2 \sigma_{\tilde{\varepsilon}}^2}$ and $\hat{\beta}_1^b = \frac{\sigma_{\tilde{r}}^2 + (p\hat{z})^2 (\sigma_{\tilde{i}}^2 + \sigma_{\tilde{\varepsilon}}^2)}{\sigma_{\tilde{r}}^2 + \sigma_{\tilde{\gamma}}^2 + (p\hat{z})^2 (\sigma_{\tilde{i}}^2 + \sigma_{\tilde{\varepsilon}}^2)}$.[20] That is, when $\Phi_1^I = \{x_1, I\}$, the stock price's sensitivity to $\tilde{x}_1$ declines if the firm discloses the true environmental impact at $t = 1$. This decline is in stark contrast to the result of section 4.2.2, where the stakeholders' observation of $\tilde{y}$ increased the investors' responsiveness to $\tilde{x}_1$ when they did not know $\tilde{y}$. There are two reasons for these different outcomes. Firstly, with disclosure of $\tilde{I}$ investors need not infer the indirect financial performance of $\tilde{x}_2$ from $\tilde{x}_1$, which diminishes the investors' responsiveness to $\tilde{x}_1$. Secondly, in case $\tilde{I}$ is disclosed at $t = 1$, $\tilde{S}_1$ (which is based on $\Phi_{0.5}^{ST} = \{y\}$) is different from $\tilde{S}_2$ (which is based on $\Phi_1^{ST} = \{I\}$). When investors do not know $\tilde{y}$, the inference $\tilde{y} - \tilde{I} = \tilde{\varepsilon}$ is not possible. Investors thus cannot "remove" the noise $\tilde{\varepsilon}$ from $\tilde{x}_1$ and since $\tilde{\varepsilon}$ is not present in $\tilde{x}_2$, $\tilde{x}_1$ becomes a worse signal for long-run financial performance. The investors' sensitivity to $\tilde{x}_1$, therefore, decreases. The decline in the sensitivity to $\tilde{x}_1$ post disclosure of $\tilde{I}$ is referred to as "signal jamming effect" of mandatory ESG disclosure because there are less incentives to "jam" and inflate $\tilde{x}_1$ when doing so elicits a smaller positive stock price reaction.

Additionally to the exogenous $\tilde{\gamma}$, transitory randomness in $\tilde{x}_1$ arises endogenously from $\tilde{\varepsilon}$ through the stakeholders use of $\tilde{y}$ and related financial consequence.[21] Post disclosure of $\tilde{I}$, the stock price's sensitivity to $\tilde{x}_1$ thus decreases even when $\tilde{\gamma} = 0$.[22] The discussion of this section highlights a more general point: actions of individuals or organizations (here ESG-interested stakeholders) that are based on imprecise information ($\tilde{y}$) and that have financial consequences ($\tilde{S}_1$) can lead to "transitory" randomness ($\tilde{\varepsilon}$) that affects financial performance ($\tilde{x}_1$). After arrival of precise information over time, random over- or understatements ($\tilde{\varepsilon}$) no longer affect stakeholder pressure and long-run financial performance ($\tilde{x}_2$). Since disclosure of $\tilde{I}$ reduces the stock price reaction to

[20] $\hat{\beta}_0^c$, $\hat{\beta}_2^c$, $\hat{\beta}_3^c$, $\hat{\beta}_0^d$, and $\hat{\beta}_2^d$ are explicitly stated in the Appendix.

[21] Randomness that is idiosyncratic to short-run financial performance often only arises exogenously. See e.g. the variable $v_t$ in Stein (1989) or $\tilde{\gamma}$ in Kanodia and Mukherji (1996).

[22] The response coefficient $\hat{\beta}_1^d$ would be $\frac{\sigma_{\tilde{r}}^2}{\sigma_{\tilde{r}}^2 + (p\hat{z})^2 \sigma_{\tilde{\varepsilon}}^2}$ if $\tilde{\gamma} = 0$. When $\tilde{I}$ is not disclosed, the inability to remove $\tilde{\varepsilon}$ from $\tilde{x}_1$ in case $\Phi_1^I = \{x_1, I\}$ does not reduce the investors' responsiveness to $\tilde{x}_1$ because then $\tilde{\varepsilon}$ also affects $\tilde{x}_2$.

financial performance $x_1$, the manager has incentives to change investment decisions. At $t = 0$, the manager expects the market valuation:

$$E[\tilde{P}_1|\Phi_0^{\mathrm{M}}] = \hat{\beta}_1^c(\theta q - \frac{q^2}{2} - \frac{s^2}{2}) + p(\beta_s s - \beta_q q) + \hat{k}^c \quad \text{if} \quad \Phi_1^I = \{x_1, y, I\}$$
$$\text{and} \quad E[\tilde{P}_1|\Phi_0^{\mathrm{M}}] = \hat{\beta}_1^d(\theta q - \frac{q^2}{2} - \frac{s^2}{2}) + p(\beta_s s - \beta_q q) + \hat{k}^d \quad \text{if} \quad \Phi_1^I = \{x_1, I\}$$

where $\hat{k}^c = \hat{\beta}_0^c + p\hat{z}_0\hat{\beta}_1^c$ and $\hat{k}^d = \hat{\beta}_0^d + p\hat{z}_0\hat{\beta}_1^d$. $\hat{k}^c$ and $\hat{k}^d$, again, summarize additive constants that do not affect $s^*$ or $q^*$. Maximizing $U_0$ with respect to $q$ and $s$ yields:

**PROPOSITION 5.** *If ESG-interested stakeholders observe imprecise nonfinancial information $\tilde{y}$ at $t = 0.5$, financial performance $\tilde{x}_1$ and nonfinancial performance $\tilde{I}$ at $t = 1$, then the equilibrium investments are:* $s_{5a}^* = \frac{b_s(1-\alpha)+p\beta_s(1+\hat{z})}{1+\alpha\hat{\beta}_1^c}$ *and* $q_{5a}^* = \frac{\theta(2-\alpha+\alpha\hat{\beta}_1^c)-p\beta_q(1+\hat{z})}{1+\alpha\hat{\beta}_1^c}$ *if* $\Phi_1^I = \{x_1, y, I\}$, *or* $s_{5b}^* = \frac{b_s(1-\alpha)+p\beta_s(1+\hat{z})}{1+\alpha\hat{\beta}_1^d}$ *and* $q_{5b}^* = \frac{\theta(2-\alpha+\alpha\hat{\beta}_1^d)-p\beta_q(1+\hat{z})}{1+\alpha\hat{\beta}_1^d}$ *if* $\Phi_1^I = \{x_1, I\}$.

The optimal investments take the same functional form regardless of whether $\Phi_1^I = \{x_1, y, I\}$ or $\Phi_1^I = \{x_1, I\}$, but critically differ in their magnitude because the investors' responsiveness to $\tilde{x}_1$ varies depending on $\Phi_1^I$. Bullet point (i) in Corollary 4 shows when investors know $\tilde{y}$, environmental performance is better when $\tilde{I}$ is disclosed than when there is no disclosure. Post disclosure of $\tilde{I}$, the stakeholders expectations reflect the true $\tilde{I}$ more accurately. The response coefficients of the stakeholders' expectation to $\tilde{y}$ and $\tilde{I}$, measured as the derivative of $E[\tilde{I}|\Phi_{t-k}^{ST}]$ with respect to $\tilde{y}$ and $\tilde{I}$, are $\hat{z} \in (0, 1)$ and 1, respectively. If the true $\tilde{I}$ is more accurately captured in the stakeholders' expectations which are highly responsive to $\tilde{I}$, every increase in $\tilde{I}$ reaps through $\tilde{S}_t = pE[\tilde{I}|\Phi_{t-k}^{ST}]$ a greater financial reward. The manager hence is incentivized to improve $\tilde{I}$ with more sustainability investments $s^*$ and reduction of $q^*$. This effect of disclosing $\tilde{I}$ has been referred to as "stakeholder effect" throughout the paper. Moreover, because investors also observe $\tilde{I}$ and a higher $\tilde{I}$ leads to better long-run financial performance, the stock price $\tilde{P}_1 = E[\tilde{x}_2|\Phi_1^{\mathrm{I}}]$ increases with $\tilde{I}$. For a given positive environmental impact, the stock price reacts more positively if there is more precise public ESG information. The reason is that because of the stakeholder effect financial benefits from ESG-interested stakeholders and thus $\tilde{x}_2$ are higher if there is more precise ESG information. That is, when there was only the public signal $\tilde{y}$, the stock price reaction to this ESG information was $\hat{\beta}_2^a = p\hat{z}(1 - \hat{\beta}_1^a)$. When there is mandatory disclosure of $\tilde{I}$, the stock price reaction to this disclosure is $\hat{\beta}_3^c = p$. This "direct stock price effect" of disclosing $\tilde{I}$ provides further motivation to take management decisions that boost $\tilde{I}$. If investors know $\tilde{y}$, the fact that unlike $\tilde{x}_2$, $\tilde{x}_1$ is affected by the noise of $\tilde{y}$ (i.e. $\tilde{\varepsilon}$) does not distort signal-jamming incentives because the inference $\tilde{y} - \tilde{I} = \tilde{\varepsilon}$ is possible. It follows that when $\Phi_1^I = \{x_1, y, I\}$, the net effect of disclosing $\tilde{I}$ is an improvement in environmental performance because the stakeholder effect and the positive stock price reaction to $\tilde{I}$ provide incentives to invest more in sustainability and less in business activities that generate negative environmental externalities.

**COROLLARY 4.** *Equilibrium nonfinancial performance, measured as* $E[\tilde{I}] = \beta_s s^* - \beta_q q^*$*:*

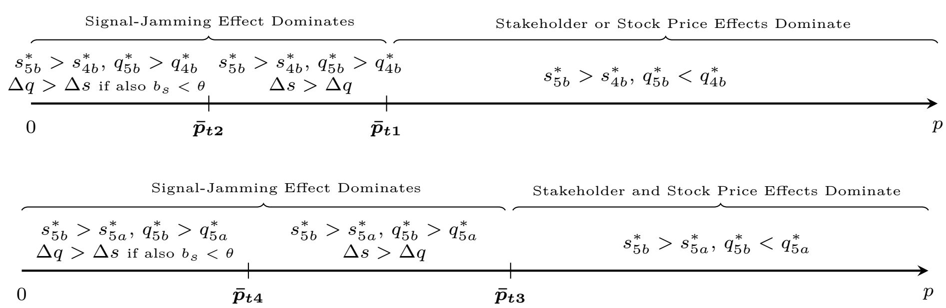
*(i) is always higher when* $\tilde{I}$ *is disclosed at t=1 than when* $\tilde{I}$ *is not disclosed if* $\Phi_1^I = \{x_1, y, I\}$*.*

*(ii) is higher when* $\tilde{I}$ *is disclosed at t=1 than when* $\tilde{I}$ *is not disclosed if* $\Phi_1^I = \{x_1, I\}$ *and a)* $b_s\beta_s > \theta\beta_q$ *or b)* $b_s\beta_s < \theta\beta_q$ *and* $p > \bar{p}_4$*.*

*(iii) is higher if* $\Phi_1^I = \{x_1, I\}$ *rather than* $\Phi_1^I = \{x_1, y, I\}$ *and given that* $\tilde{I}$ *is disclosed at t=1 if a)* $b_s\beta_s > \theta\beta_q$ *or b)* $b_s\beta_s < \theta\beta_q$ *and* $p > \bar{p}_5$*.*

Bullet point (ii) shows that when investors do not know $\tilde{y}$, as well as when the conditions of Corollary 4 are not satisfied, disclosure of $\tilde{I}$ is environmentally detrimental. This result occurs even though the stakeholder effect and positive stock price reaction to a higher $\tilde{I}$ are present as outlined above. Key to this outcome is the reduction in signal-jamming as a result of the decline in the stock price's sensitivity to $\tilde{x}_1$. If the stock price reaction to a given increase in $\tilde{x}_1$ is less pronounced, the manager has less incentives to engage in under-investment to boosts $\tilde{x}_1$ and both $q^*$ and $s^*$ increase. When $b_s\beta_s > \theta\beta_q$, the manager predominantly reacts with an increase in $s^*$ because the direct and indirect financial benefits of sustainability investments are high, which subsequently enhances ESG performance. If $\theta\beta_q > b_s\beta_s$, the condition $p > \bar{p}_4$ arises to ensures the stakeholder effect is dominant such that the increase in $s^*$ exceeds the increase in $q^*$. Under bullet point (iii), disclosure of $\tilde{I}$ is taken as given and the conditions for superior environmental performance when $\Phi_1^I = \{x_1, I\}$ rather than $\Phi_1^I = \{x_1, y, I\}$ are examined. In both cases, there exist the stakeholder effect and the positive stock price reaction to $\tilde{I}$ that stimulate higher $s^*$ and lower $q^*$. However, disclosure of $\tilde{I}$ only elicits a signal-jamming effect that both induces further growth in $s^*$ and $q^*$ when $\Phi_1^I = \{x_1, I\}$. The conditions in bullet point (iii) ensure that the increase in $s^*$ outweighs the increase in $q^*$ because either the direct or the indirect financial benefit of more sustainability investments are high.

Generally, whether disclosure of $\tilde{I}$ generates an environmental improvement rests on the incentives of the manager to change investments decisions because of a) the stakeholder effect (i.e. the financial repercussion of the ESG-interested stakeholders' observation of $\tilde{I}$) b) the stock price reaction to $\tilde{I}$, and c) the signal-jamming effect (i.e. changes in the market's sensitivity to $\tilde{x}_1$ after disclosure of $\tilde{I}$). The first two effects both generate higher $s^*$ and lower $q^*$, but the signal-jamming effect counteracts reductions in $q^*$ and can lead to the growth in $q^*$ exceeding that of $s^*$. Figures 3a and 3b demonstrate under what circumstances the signal-jamming effect dominates.




Figures 3a and 3b: Stakeholder and Stock Price vs Signal-jamming Effect of ESG Disclosure

Figure 3a compares the change in the investment levels prior vs. post disclosure of $\tilde{I}$ given that $\Phi_1^I = \{x_1, I\}$, whilst Figure 3b takes disclosure of $\tilde{I}$ as given and examines the change in investments when $\Phi_1^I = \{x_1, I\}$ rather than $\Phi_1^I = \{x_1, y, I\}$. Based on the magnitude of $p$, three distinct areas arise.[23] If $p$ is very high (i.e. above $\bar{p}_{t1}$ or $\bar{p}_{t3}$), $\Delta s > 0$ and $\Delta q < 0$. In this case, disclosure of $\tilde{I}$ together with $\Phi_1^I = \{x_1, I\}$ induces significant environmental improvements. For moderate levels of $\bar{p}$, $\Delta s > 0$, $\Delta q > 0$ and $\Delta s > \Delta q$ such that there is a less pronounced environmental improvement in case $\tilde{I}$ is disclosed and $\Phi_1^I = \{x_1, I\}$ (assuming $\beta_q = \beta_s$). Finally, for very low levels of $\bar{p}$ (i.e. below $\bar{p}_{t2}$ or $\bar{p}_{t4}$) and if $b_s < \theta$, the signal-jamming effect leads to the outcome that the increase in $q^*$ exceeds the increase in $s^*$. In this case and if $\beta_q = \beta_s$, environmental performance is worse when $\Phi_1^I = \{x_1, I\}$ and $\tilde{I}$ is disclosed than when $\tilde{I}$ is not disclosed (Figure 3a), or when investors do not observe $\tilde{y}$ compared to when they know $\tilde{y}$ given that $\tilde{I}$ is disclosed (Figure 3b). In Figure 3a, the area where the signal-jamming effect dominates is smaller than in Figure 3b. That is, when investors do not know $\tilde{y}$, moving from no disclosure of $\tilde{I}$ to revealing $\tilde{I}$ less likely results in environmental deterioration than when disclosure of $\tilde{I}$ is given but investors do not know

[23]The thresholds for $p$ are derived in the Appendix.

$\tilde{y}$ rather than when they observe $\tilde{y}$. When the players learn the true $\tilde{I}$ through corporate disclosure, their expectations are highly responsive to this accurate information, thus leading to a particularly strong stakeholder effect and positive stock price reaction to $\tilde{I}$. The analysis shows that the extent with which the stakeholders' expectations of the firm's environmental impact generate additional financial revenues or costs, i.e. $p$, is critical in assessing the change in environmental performance following mandatory ESG disclosure.

The question arises, if the setting with disclosure of $\tilde{I}$ and $\Phi_1^I = \{x_1, y, I\}$ leads to improvements in nonfinancial performance, why do stakeholders not voluntarily disclose $\tilde{y}$ to investors? Stakeholders only benefit from publicizing $\tilde{y}$ when $p$ is sufficiently low, otherwise the setting with $\Phi_1^I = \{x_1, I\}$ generates superior nonfinancial performance. ESG-interested stakeholders that are aware of this effect would avoid revealing $\tilde{y}$ to investors unless $p$ is low. Stakeholders could also refrain from publicizing $\tilde{y}$ if verifying information is too expensive or there are proprietary costs. Assuming there are incentives to disclose $\tilde{y}$, the question then arises whether investors will use this information to value the firm. Investors could abstain from $\tilde{y}$ if they believe the information $\tilde{y}$ is not credible or perhaps biased by stakeholders to further their interests.[24] Any imprecise disclosure of $\tilde{y}$ means the investors' inference $\tilde{y} - \tilde{I}$ and hence eliminating $\tilde{\varepsilon}$ from $\tilde{x}_1$ is not possible. The same is true when investors make mistakes in their inference $\tilde{y} - \tilde{I}$, i.e. in disentangling $\tilde{\varepsilon}$ from $\tilde{i}$.[25] In these cases, the signal-jamming effect of disclosing $\tilde{I}$ is still present. Even if there are no such mistakes, and investors believe stakeholders communicate credible and unbiased information, when the manager assumes investors are uncertain of $\tilde{y}$, the investment levels are $q^* = q_{5b}^*$ and $s^* = s_{5b}^*$. The reason is that the manager anticipates that the firm is priced based on $E[\tilde{x}_2|x_1, I]$, and chooses $q^*$ and $s^*$ accordingly. Corollary 5 below shows that under the additional assumptions that $\theta = b_s$, and $\beta_q = \beta_s$, $E[\tilde{x}_2|x_1, I]$ strictly leads to superior financial performance over $E[\tilde{x}_2|x_1, y, I]$. The manager might assume that stock market participants that are invested in the company prefer to value the firm according to $\tilde{P}_1 = E[\tilde{x}_2|x_1, I]$. Both bullet point (ii) and (iii) of Corollary 5 imply that for financial performance, uncertainty of $\tilde{y}$ and a less precise signal $\tilde{x}_1$ can be beneficial because under-investment is mitigated.[26] Bullet point (i) mirrors the results of Corollary 3 and suggests when investors know $\tilde{y}$, disclosure of ESG performance and subsequent

[24] The stakeholders' communication of $\tilde{y}$ to investors can be framed as a cheap talk game. In this class of games, a babbling-equilibrium where no information is conveyed always exists, whilst full disclosure is not a Nash equilibrium (Crawford and Sobel, 1982).

[25] Kanodia and Mukherji (1996) model "noisy separation" of operating cash flows and investment. Similarly, Kanodia et al. (2004) model classification errors in a real effects model, albeit with focus on measuring intangibles.

[26] Dye (2001), Kanodia et al. (2005), Gigler et al. (2014), and real effects models in general already highlighted that more transparency is not necessarily desirable for economic efficiency.

growth (reduction) of investment in $s$ ($q$) is only financially beneficial if either $a$) the direct and indirect financial benefit of $s$ is high, or $b$) ESG-interested stakeholders have a sufficiently high influence over financial performance (i.e. $p > \bar{p}_6$) and hence the indirect financial benefit of $s$ is particularly large.

**COROLLARY 5.** *Equilibrium financial performance, measured as $E[FP] = E[\tilde{x}_1^*] + E[\tilde{x}_2^*]$:*

*(i) is higher when $\tilde{I}$ is disclosed at t=1 than when $\tilde{I}$ is not disclosed if $\Phi_1^I = \{x_1, y, I\}$ and a) $b_s\beta_s > \theta\beta_q$ or b) $b_s\beta_s < \theta\beta_q$ and $p > \bar{p}_6$.*

*(ii) is always higher when $\tilde{I}$ is disclosed at t=1 than when $\tilde{I}$ is not disclosed if $\Phi_1^I = \{x_1, I\}$, $\theta = b_s$, and $\beta_q = \beta_s$.*

*(iii) is always higher when $\Phi_1^I = \{x_1, I\}$ rather than $\Phi_1^I = \{x_1, y, I\}$ given that $\tilde{I}$ is disclosed at t=1, $\theta = b_s$, and $\beta_q = \beta_s$.*

## 4.4 Value Relevance and Empirical Implications

The signal-jamming effect can be understood in the light of the value relevance literature which examines, amongst other issues, the stock price reaction to (information of) financial performance.[27] Corollary 6 summarizes the change in the stock price $\tilde{P}_1 = E[\tilde{x}_2|\Phi_1^I]$ for a given change of short-run financial performance $\tilde{x}_1$, as detailed in sections 4.2 and 4.3.

**COROLLARY 6.** The stock price's sensitivity to the financial performance $\tilde{x}_1$, measured as $\frac{\partial \tilde{P}_1}{\partial \tilde{x}_1}$, compares as follows:

(i) Without disclosure of $\tilde{I}$, the stock price's sensitivity to $\tilde{x}_1$ is greater if investors do not know $\tilde{y}$ than if they know $\tilde{y}$ (i.e. $\hat{\beta}_1^b > \hat{\beta}_1^a$). This difference disappears when $\gamma = 0$.

(ii) With disclosure of $\tilde{I}$, the stock price's sensitivity to $\tilde{x}_1$ is lower if investors do not know $\tilde{y}$ than if they know $\tilde{y}$ (i.e. $\hat{\beta}_1^d < \hat{\beta}_1^c$). This difference does not disappear when $\gamma = 0$.

(iii) When investors know $\tilde{y}$, the stock price's sensitivity to $\tilde{x}_1$ is the same regardless of whether $\tilde{I}$ is disclosed, or not (i.e. $\hat{\beta}_1^a = \hat{\beta}_1^c$).

The difference in bullet points (i) and (ii) arises because without disclosure of $\tilde{I}$, investors have to infer the long-run financial repercussions of stakeholder pressure from $\tilde{x}_1$. With disclosure of $\tilde{I}$, the

[27] See e.g. Lev (1989) or Ewert and Wagenhofer (2005) for discussion and related citations.

noise $\tilde{\varepsilon}$ of the imprecise ESG information $\tilde{y}$ that affects $\tilde{x}_1$ further impairs the value relevance of $\tilde{x}_1$ if investors do not observe $\tilde{y}$. Bullet point (iii) stems from the possibility to eliminate the noise $\tilde{\varepsilon}$ from $\tilde{x}_1$ if $\tilde{y}$ is observed.

Comparative statics of the stock price's sensitivity to short-run financial performance $\frac{\partial \tilde{P}_1}{\partial \tilde{x}_1} = \hat{\beta}_1^d$ yield for the case that investors do not observe $\tilde{y}$:

**COROLLARY 7.** $\frac{\partial \hat{\beta}_1^d}{\partial \sigma_{\tilde{r}}} > 0$, $\frac{\partial \hat{\beta}_1^d}{\partial \sigma_{\tilde{i}}} < 0$, $\frac{\partial \hat{\beta}_1^d}{\partial p} < 0$, $\frac{\partial \hat{\beta}_1^d}{\partial \sigma_{\tilde{\gamma}}} < 0$, and $\frac{\partial \hat{\beta}_1^d}{\partial \sigma_{\tilde{\varepsilon}}} = \begin{cases} > 0 \text{ if } \sigma_{\tilde{\varepsilon}} > \sigma_{\tilde{i}} \\ < 0 \text{ if } \sigma_{\tilde{\varepsilon}} < \sigma_{\tilde{i}}. \end{cases}$ *That is, the stock price's sensitivity to $\tilde{x}_1$ increases in $\sigma_{\tilde{r}}$, decreases in $\sigma_{\tilde{i}}$, $p$ as well as $\sigma_{\tilde{\gamma}}$, and can increase or decrease in $\sigma_{\tilde{\varepsilon}}$ depending on the sign of $\sigma_{\tilde{\varepsilon}} - \sigma_{\tilde{i}}$.*

The derivatives are stated in the Appendix. Both $\tilde{x}_1$ and $\tilde{x}_2$ are affected by $\tilde{r}$, which leads to $Cov(\tilde{x}_2, \tilde{x}_1) > 0$. $\tilde{x}_1$, therefore, becomes a better signal for $\tilde{x}_2$ if most of the variance of $\tilde{x}_1$ is attributable to $\tilde{r}$. It follows that $\frac{\partial \hat{\beta}_1^d}{\partial \sigma_{\tilde{r}}} > 0$.[28] If $\sigma_{\tilde{i}}$ increases, stakeholders become more responsive to $\tilde{y}$, as reflected by a higher $\hat{z} = \frac{\sigma_{\tilde{i}}^2}{\sigma_{\tilde{i}}^2 + \sigma_{\tilde{\varepsilon}}^2}$. More of the noise of $\tilde{y}$ (i.e. $\tilde{\varepsilon}$) is hence inherited in $\tilde{x}_1$ (through $\tilde{S}_1 = p(\hat{z}_0 + \hat{z}y)$). Similarly, a higher $p$ means $\tilde{\varepsilon}$ has a greater effect on $\tilde{x}_1$ because $E[\tilde{I}|\Phi_{0.5}^{ST}]$ has a more substantial effect on $\tilde{x}_1$. Because both a higher $\sigma_{\tilde{i}}$ and $p$ raise the influence of $\tilde{\varepsilon}$ on $\tilde{x}_1$, but $\tilde{\varepsilon}$ does not affect $\tilde{x}_2$, the stock price's sensitivity to $\tilde{x}_1$ decreases with these parameters and $\frac{\partial \hat{\beta}_1^d}{\partial \sigma_{\tilde{i}}} < 0$ as well as $\frac{\partial \hat{\beta}_1^d}{\partial p} < 0$. Higher $\sigma_{\tilde{i}}$ and $p$ also mean $\tilde{x}_1$ better reflects $\tilde{i}$, and $\tilde{i}$ is present in $\tilde{x}_2$. However, investors can infer $\tilde{i}$ from the disclosure of $\tilde{I}$. They do not benefit (i.e. do not learn anything new) when $\tilde{x}_1$ reflects $\tilde{i}$ accurately. $\frac{\partial \hat{\beta}_1^d}{\partial \sigma_{\tilde{i}}}$ and $\frac{\partial \hat{\beta}_1^d}{\partial p}$ are hence strictly negative. With disclosure of $\tilde{I}$, both $\tilde{\gamma}$ and $\tilde{\varepsilon}$ are noisy components that are idiosyncratic to short-run financial performance and that contain no valuable information to predict $\tilde{x}_2$. $\hat{\beta}_1^d$ strictly decreases with $\sigma_{\tilde{\gamma}}$, which is typically the case with the variance of transitory noise.[29] To understand the sign of $\frac{\partial \hat{\beta}_1^d}{\partial \sigma_{\tilde{\varepsilon}}}$, note that there is a two-fold effect of $\sigma_{\tilde{\varepsilon}}$. Firstly, the size of $\sigma_{\tilde{\varepsilon}}$ directly determines how much of the variability of $\tilde{x}_1$ is attributable to $\tilde{\varepsilon}$. Secondly, $\sigma_{\tilde{\varepsilon}}$ affects the responsiveness $\hat{z}$ of stakeholders to $\tilde{y}$, determines how much of $\tilde{\varepsilon}$ is reflected in $\tilde{x}_1$, and hence also determines the effect of $\sigma_{\tilde{\varepsilon}}$ on $\tilde{x}_1$ through this channel. If $\sigma_{\tilde{\varepsilon}} < \sigma_{\tilde{i}}$, stakeholders are very responsive to $\tilde{y}$ and $\tilde{\varepsilon}$ takes a prominent role in $\tilde{x}_1$. In this case, the stock price's sensitivity to $\tilde{x}_1$ would increase if $\sigma_{\tilde{\varepsilon}}$ goes up because the benefit that stakeholders are less responsive to $\tilde{y}$ and hence less of $\tilde{\varepsilon}$ is reflected in $\tilde{x}_1$ dominates (vice versa

[28] This is a "standard" result. See e.g. the effect of $\sigma_{\tilde{v}}^2$ on $\beta$ in Fischer and Verrecchia, (2000).

[29] See e.g. the effect of $\sigma_{\tilde{n}}^2$ on $\beta$ in Fisher and Verrecchia, (2000) or Ewert and Wagenhofer (2015). $\sigma_{\tilde{n}}^2$ stems from an imprecise accounting system and the earnings response coefficients are more evolved in these papers, but they strictly decrease in the variance of this noise. See also Holthausen and Verrecchia (1988).

when $\sigma_{\tilde{\varepsilon}} > \sigma_{\tilde{i}}$). The extent of the effect of $\tilde{\varepsilon}$ on $\tilde{x}_1$ is effectively endogenously determined by the stakeholders' responsive to $\tilde{y}$. A higher $\sigma_{\tilde{\varepsilon}}$ can increase the value relevance of $\tilde{x}_1$ because it reduces this responsiveness and thus the effect of $\tilde{\varepsilon}$ on $\tilde{x}_1$. Whether the idiosyncratic noise in short-run financial performance stems from an exogenous source (e.g. random cost over- and under-runs, an imprecise accounting system etc.) or is inherited from actions (here stakeholder pressure) that are based on other imprecise information (here $\tilde{y}$) and that affect financial performance leads to different conclusions about the effect of the variance of noise on value relevance.

Moreover, assume there is disclosure of $\tilde{I}$, investors do not observe $\tilde{y}$, and the stock price is given by:

$$\tilde{P}_1 = \hat{\alpha} + \hat{\beta}_1 \tilde{x}_1(\tilde{y}(\tilde{I}), o) + \hat{\beta}_2 \tilde{I}$$

where $o$ summarizes other important determinants of $\tilde{x}_1$. Regressing stock prices against data of $\tilde{x}_1$ and $\tilde{I}$ leads to multicollinearity because $\tilde{x}_1$ is affected by $\tilde{y}$, which itself is a function of $\tilde{I}$. When $p$ and $\sigma^2_{\tilde{i}}$ are high or $\sigma^2_{\tilde{\varepsilon}}$ is low, pressure from ESG-interested stakeholders has a significant impact on financial performance and the correlation between the explanatory variables is particularly pronounced. The correlation between financial and nonfinancial information grows because the financial statements reflect nonfinancial outcomes to a greater extent. Omission of $\tilde{I}$ from OLS-estimates to avoid multicollinearity is problematic because of a potential omitted-variable bias and invalid standard errors. $\tilde{I}$ both is an important explanatory variable of $\tilde{P}_1$ (a higher $\tilde{I}$ boosts long-run financial performance, thus induces a positive stock price reaction) and also affects financial performance $\tilde{x}_1$ (a higher $\tilde{I}$ is associated with a higher $\tilde{y}$, which affects $\tilde{x}_1$). Since $Cov(\tilde{x}_1, \tilde{I}) > 0$ and $Cov(\tilde{P}_1, \tilde{I}) > 0$, omission of $\tilde{I}$ will induce an upward-biased OLS-estimate of $\hat{\beta}_1$. Finally, it should be noted that the desirability of higher value relevance of $\tilde{x}_1$ depends on the policymakers' objectives. Greater value relevance stimulates under-investment which dampens financial performance, but is environmentally beneficial if firms predominantly cut business activities that produce negative externalities.

# 5 Conclusion

This paper examines the real effects of disclosing nonfinancial information in settings that differ in the information endowment of ESG-interested stakeholders and investors. The analysis contributes insights into the financial and nonfinancial consequences of an ESG disclosure mandate, as advocated e.g. by the European Supervisory Authorities (ESAs, 2020). Proponents of ESG reporting frequently argue that disclosing a firm's externalities creates public pressure to reduce environmentally harmful business activities and invest in sustainability. I explicitly model such stakeholder pressure for strong ESG performance and find an additional effect of ESG disclosure that can diminish environmental improvements. In particular, ESG disclosure reduces the investors' sensitivity to short-run financial performance and elicits more investments in business activities whose costs are incurred in the short-run. If the firm predominantly increases activities that produce negative externalities, ESG performance worsens (the paper provides the conditions when this occurs). This finding does not imply ESG transparency is generally disadvantageous to the environment. Indeed, the analysis shows the influence of ESG-interested stakeholders on financial performance and the positive stock price reaction to strong ESG performance increase with more precise ESG information, which boosts environmentally beneficial management decisions. Instead, the analysis aims to highlight a so far neglected effect of ESG disclosure, i.e. unintended changes in the stock price reaction to financial performance, that can work against environmental improvements. An empirical examination of the relative strength of the various effects could provide further insights.

The paper derives conditions for ESG transparency to favor or worsens financial performance. ESG transparency effectively results in firms internalizing the financial benefits of positive and costs of negative environmental externalities to a greater extent. Ceteris paribus, the greater stakeholder pressure for strong ESG performance, the better nonfinancial performance, thus the more likely financial performance improves with the greater internalization post introduction of mandatory ESG disclosure. Empiricists could test this theoretical result in a difference-in-difference setting. I derive a threshold for the influence of ESG-interested stakeholders on financial performance above which firms have sufficient incentives to enhance ESG performance such that ESG transparency is financially beneficial. This threshold rationalizes conflicting empirical findings of the correlation between nonfinancial reporting and financial performance and provides a potential explanation why some companies cease production following an ESG disclosure mandate (Christensen et al., 2017). In addition, I find that post ESG disclosure, the reduction in the investors' sensitivity to short-run financial performance mitigates under-investment and is financially beneficial.

Although the paper focuses on stakeholders that care about environmental externalities, the model applies to other interest groups that observe information and exert financial pressure based on their objectives. Examples are lobbyists (e.g. labor unions) or legal authorities. The findings are also robust to allowing for altruistic preferences of managers or investors for strong ESG performance. The model's main limitation is that information asymmetry between the manager and firm-external players stems only from the unobservability of the manager's decisions. Future research could model further information asymmetries, e.g. regarding the marginal environmental impact of decisions. Moreover, ESG disclosure-induced changes in the investors' sensitivity to financial performance depend on differences in the information sets of non-investor stakeholders and investors. Similar results would, however, arise from noisy separation of ESG performance-related earnings from other operating earnings (Kanodia and Mukherji, 1996).

Finally, the assessment of the financial and nonfinancial consequences of ESG disclosure provides insights for regulators and standardsetters that aim to improve ESG performance through ESG transparency. Ultimately (the interconnectedness of) financial *and* nonfinancial disclosures, and particularly related stakeholder as well as stock price pressure, affect management decisions. More broadly, the findings thus suggest it is vital that policymakers jointly consider nonfinancial and financial reporting when attempting to change corporate behavior through ESG transparency.

# Appendix A

All proofs are based on $\theta, b_s, \beta_q, \beta_s$, $p > 0$ and $\alpha$, $\hat{z}, \hat{\beta}_1, \hat{\beta}_1^a, \hat{\beta}_1^b, \hat{\beta}_1^c, \hat{\beta}_1^d \in (0,1)$.

**Proof of Corollary 1**

The expected environmental impact is given by $E[\tilde{I}] = E[\beta_s s^* - \beta_q q^* + \tilde{i}] = \beta_s s^* - \beta_q q^*$ in equilibrium. For $E[\tilde{I}]$ to be greater when $\Phi_1^I = \{x_1\}$ rather than $\Phi_1^I = \{q, s\}$, the following inequality needs to hold:

$$\beta_s s_3^* - \beta_q q_3^* > \beta_s s_2^* - \beta_q q_2^* \; = \; \frac{\beta_s b_s(1-\alpha)}{1+\alpha\hat{\beta}_1} - \frac{\beta_q \theta(2-\alpha+\alpha\hat{\beta}_1)}{1+\alpha\hat{\beta}_1} > \beta_s b_s - \beta_q 2\theta.$$

This inequality simplifies to:

$$\beta_q \theta \frac{(1+\hat{\beta}_1)\alpha}{1+\alpha\hat{\beta}_1} > \beta_s b_s \frac{(1+\hat{\beta}_1)\alpha}{1+\alpha\hat{\beta}_1} \quad = \quad \beta_q \theta > \beta_s b_s.$$

Hence, whenever $\beta_q \theta > \beta_s b_s$, $E[\tilde{I}]$ is greater when $\Phi_1^I = \{x_1\}$ rather than $\Phi_1^I = \{q, s\}$.

Moreover note that the direct financial benefit in the short- and long-run are $E[F_1] = \theta q - \frac{q^2}{2} - \frac{s^2}{2}$ and $E[F_2] = \theta q + b_s s$, respectively. Substituting $q = q_2^*$ and $s = s_2^*$ yields:

$$E_2[F_1] = -\frac{b_s^2}{2} \quad \text{and} \quad E_2[F_2] = 2\theta^2 + b_s^2.$$

Substituting $q = q_3^*$ and $s = s_3^*$ yields:

$$E_3[F_1] = \frac{\theta^2(2 - \alpha + \alpha\hat{\beta}_1)\alpha(1 + \hat{\beta}_1)}{2(1 + \alpha\hat{\beta}_1)^2} - \frac{b_s^2(1 - \alpha)^2}{2(1 + \alpha\hat{\beta}_1)^2} \quad \text{and}$$

$$E_3[F_2] = \frac{\theta^2[2 - \alpha + \alpha\hat{\beta}_1]}{1 + \alpha\hat{\beta}_1} + \frac{b_s^2(1 - \alpha)}{1 + \alpha\hat{\beta}_1}.$$

For the expected (direct) short-run financial performance to be larger when $\Phi_1^I = \{x_1\}$ rather than $\Phi_1^I = \{q, s\}$, $E_3[F_1] - E_2[F_1] > 0$ needs to hold. Note that:

$$E_3[F_1] - E_2[F_1] = \frac{(b_s^2 + \theta^2)\alpha(1 + \hat{\beta}_1)(2 + \alpha(\hat{\beta}_1 - 1))}{2(1 + \alpha\hat{\beta}_1)^2} > 0.$$

Since $2 + \alpha(\hat{\beta}_1 - 1) > 0$ because $\alpha, \hat{\beta}_1 \in (0, 1)$, the above term is strictly greater than zero. This confirms that $E_3[F_1] > E_2[F_1]$. Furthermore, note that $E_2[F_2] > E_3[F_2]$ holds always because $2\theta^2 > \frac{\theta^2[2-\alpha+\alpha\hat{\beta}_1]}{1+\alpha\hat{\beta}_1}$ and $b_s^2 > \frac{b_s^2(1-\alpha)}{1+\alpha\hat{\beta}_1}$. Finally, I show that $E_2[F_1] + E_2[F_2] > E_3[F_1] + E_3[F_2]$. Note that:

$$E_2[F_1] + E_2[F_2] = \frac{4\theta^2 + b_s^2}{2} \text{ and}$$
$$E_3[F_1] + E_3[F_2] = \frac{\theta^2(2 + \alpha + 3\alpha\hat{\beta}_1)(2 + \alpha(\hat{\beta}_1 - 1)) - b_s^2(1 + \alpha + 2\alpha\hat{\beta}_1)(\alpha - 1)}{2(1 + \alpha\hat{\beta}_1)^2}.$$

$E_2[F_1] + E_2[F_2] - (E_3[F_1] + E_3[F_2]) > 0$ needs to hold, whereby:

$$E_2[F_1] + E_2[F_2] - (E_3[F_1] + E_3[F_2]) = \frac{\alpha^2(b_s^2 + \theta^2)(1 + \hat{\beta}_1)^2}{2(1 + \alpha\hat{\beta}_1)^2}.$$

The above term is greater than zero since $\alpha, \hat{\beta}_1 \in (0, 1)$ and $b_s, \theta > 0$. *Q.E.D.*

**Derivation of the Market Prices in Section 4.2.2**

Here I derive $\tilde{P}_1$ when $\tilde{y}$ is the only signal about $\tilde{I}$. As outlined in section 4.2.2, $\tilde{x}_1 = \tilde{R} - \tilde{C} + \tilde{S}_1$ and $\tilde{x}_2 = \tilde{R} + \tilde{B}_s + \tilde{S}_2$, where $\tilde{S}_1 = \tilde{S}_2 = p(\hat{z}_0 + \hat{z}y)$. First, consider $\Phi_1^I = \{x_1, y\}$, i.e. investors know $\tilde{y}$. Applying basic properties of conditional expectations and substituting $\tilde{x}_2$ into the investors' conditional expectation of $\tilde{x}_2$, i.e. $\tilde{P}_1 = E[\tilde{x}_2|x_1, y]$, leads to:

$$E[\tilde{R} + \tilde{B}_s + p(\hat{z}_0 + \hat{z}y)|x_1, y] = E[\tilde{R} + \tilde{B}_s|x_1, y] + pE[\hat{z}_0 + \hat{z}y|x_1, y].$$

Since $E[\tilde{y}|x_1, y] = y$ and $p$, $\hat{z}_0$, and $\hat{z}$ (given the stakeholders' conjectures) are constants, this further simplifies to:

$$E[\tilde{x}_2|x_1, y] = E[\tilde{R} + \tilde{B}_s|x_1, y] + p(\hat{z}_0 + \hat{z}y).$$

Given the investors' conjectures ($\hat{q}$, $\hat{s}$) and the projection theorem with normal variables:

$$E[\tilde{R} + \tilde{B}_s|x_1, y] =$$

$$E[\hat{R} + \hat{B}_s] + \begin{bmatrix} \mathrm{Cov}(\tilde{R} + \tilde{B}_s, \tilde{x}_1) & \mathrm{Cov}(\tilde{R} + \tilde{B}_s, \tilde{y}) \end{bmatrix} \begin{bmatrix} \mathrm{Var}(\tilde{x}_1) & \mathrm{Cov}(\tilde{x}_1, \tilde{y}) \\ \mathrm{Cov}(\tilde{x}_1, \tilde{y}) & \mathrm{Var}(\tilde{y}) \end{bmatrix}^{-1} \begin{bmatrix} x_1 - E[\hat{x}_1] \\ y - E[\hat{y}] \end{bmatrix}$$

where $\mathrm{Cov}(\tilde{R} + \tilde{B}_s, \tilde{x}_1) = \sigma_{\tilde{r}}^2$, $\mathrm{Cov}(\tilde{R} + \tilde{B}_s, \tilde{y}) = 0$, $\mathrm{Cov}(\tilde{x}_1, \tilde{y}) = p\hat{z}(\sigma_{\tilde{i}}^2 + \sigma_{\tilde{\varepsilon}}^2)$, $\mathrm{Var}(\tilde{x}_1) = \sigma_{\tilde{r}}^2 + \sigma_{\gamma}^2 + (p\hat{z})^2(\sigma_{\tilde{i}}^2 + \sigma_{\tilde{\varepsilon}}^2)$, and $\mathrm{Var}(\tilde{y}) = \sigma_{\tilde{i}}^2 + \sigma_{\tilde{\varepsilon}}^2$. These results follow from the independence assumptions of the random variables as outlined in section 3. Applying matrix algebra yields:

$$E[\tilde{R} + \tilde{B}_s|x_1, y] = E[\hat{R} + \hat{B}_s] + \hat{\beta}_1^a(x_1 - E[\hat{x}_1]) - p\hat{z}\hat{\beta}_1^a(y - E[\hat{y}])$$

where $\hat{\beta}_1^a = \frac{\sigma_{\tilde{r}}^2}{\sigma_{\tilde{r}}^2+\sigma_{\tilde{\gamma}}^2}$. Substituting this back into $E[\tilde{x}_2|x_1, y]$ and further simplifying equals:

$$\tilde{P}_1 = E[\tilde{x}_2|x_1, y] = E[\hat{R} + \hat{B}_s + \hat{\beta}_1^a(x_1 - E[\hat{x}_1]) - p\hat{z}\hat{\beta}_1^a(y - E[\hat{y}]) + p(\hat{z}_0 + \hat{z}y)] =$$

$$\tilde{P}_1 = \hat{\beta}_0^a + \hat{\beta}_1^a x_1 + \hat{\beta}_2^a y$$

$$\text{where: } \hat{\beta}_0^a = E[\hat{R}] + E[\hat{B}_s] - \hat{\beta}_1^a E[\hat{x}_1] + p\hat{z}\hat{\beta}_1^a E[\hat{y}] + p\hat{z}_0,$$

$$\hat{\beta}_1^a = \frac{\sigma_{\tilde{r}}^2}{\sigma_{\tilde{r}}^2 + \sigma_{\tilde{\gamma}}^2},$$

$$\text{and } \hat{\beta}_2^a = p\hat{z}(1 - \hat{\beta}_1^a).$$

Alternatively, when $\Phi_1^I = \{x_1\}$, the stock price is given by:

$$E[\tilde{x}_2|x_1] = E[\hat{x}_2] + \frac{Cov(\tilde{x}_2, \tilde{x}_1)}{Var(\tilde{x}_1)}(x_1 - E[\hat{x}_1]).$$

Since $\text{Cov}(\tilde{x}_2, \tilde{x}_1) = \sigma_{\tilde{r}}^2 + (p\hat{z})^2(\sigma_{\tilde{i}}^2 + \sigma_{\tilde{\varepsilon}}^2)$ and $\text{Var}(\tilde{x}_1) = \sigma_{\tilde{r}}^2 + \sigma_{\gamma}^2 + (p\hat{z})^2(\sigma_{\tilde{i}}^2 + \sigma_{\tilde{\varepsilon}}^2)$, this reduces to:

$$\tilde{P}_1 = \hat{\beta}_0^b + \hat{\beta}_1^b x_1$$

$$\text{where: } \hat{\beta}_0^b = E[\hat{x}_2] - \hat{\beta}_1^b E[\hat{x}_1],$$

$$\text{and } \hat{\beta}_1^b = \frac{\sigma_{\tilde{r}}^2 + (p\hat{z})^2(\sigma_{\tilde{i}}^2 + \sigma_{\tilde{\varepsilon}}^2)}{\sigma_{\tilde{r}}^2 + \sigma_{\gamma}^2 + (p\hat{z})^2(\sigma_{\tilde{i}}^2 + \sigma_{\tilde{\varepsilon}}^2)}.$$

Moreover, because $\hat{\beta}_1^b > \hat{\beta}_1^a$, investors are more sensitive to short-run financial performance when $\Phi_1^I = \{x_1\}$ rather than $\Phi_1^I = \{y, x_1\}$. *Q.E.D.*

**Proof of Corollary 2**

For bullet point (i) of Corollary 2, environmental performance in equilibrium, i.e. $E[\tilde{I}] = \beta_s s^* - \beta_q q^*$, has to be higher when $s^* = s_{4a}^*$ and $q^* = q_{4a}^*$ rather than $s = s_3^*$ and $q^* = q_3^*$. Since $s_{4a}^* > s_3^*$ and $q_{4a}^* < q_3^*$, this is always satisfied. Moreover, let $E_{4b}[\tilde{I}]$ and $E_3[\tilde{I}]$ denote the expected environmental performance when $s^* = s_{4b}^*$ and $q^* = q_{4b}^*$ or $s^* = s_3^*$ and $q^* = q_3^*$, respectively. For bullet point (ii) of Corollary 2, $E_{4b}[\tilde{I}] - E_3[\tilde{I}] > 0$ needs to hold, where $E_{4b}[\tilde{I}] - E_3[\tilde{I}] = \frac{p\hat{z}(\beta_q^2+\beta_s^2)(2+\alpha(\hat{\beta}_1^b-1))}{1+\alpha\hat{\beta}_1^b} + \frac{(\hat{\beta}_1^b-\hat{\beta}_1^a)(\alpha-1)\alpha(b_s\beta_s-\theta\beta_q)}{(1+\alpha\hat{\beta}_1^a)(1+\alpha\hat{\beta}_1^b)}$. Since the first term is strictly positive, $\hat{\beta}_1^b > \hat{\beta}_1^a$, and $\alpha - 1$ is negative, $E_{4b}[\tilde{I}] - E_3[\tilde{I}] > 0$ holds if $\theta\beta_q > b_s\beta_s$. This fact yields condition a) of bullet point (ii). Multiplying both sides of $E_{4b}[\tilde{I}] - E_3[\tilde{I}] > 0$ with $(1 + \alpha\hat{\beta}_1^a)(1 + \alpha\hat{\beta}_1^b)$ (which is strictly positive) yields:

$$p\hat{z}(\beta_q^2+\beta_s^2)(2+\alpha(\hat{\beta}_1^b-1))(1+\alpha\hat{\beta}_1^a)+(\hat{\beta}_1^b-\hat{\beta}_1^a)(\alpha-1)\alpha(b_s\beta_s-\theta\beta_q)>0.$$

Solving for $p$ together with $\theta\beta_q<b_s\beta_s$ provides condition b) of bullet point (ii):

$$p>\frac{(\hat{\beta}_1^b-\hat{\beta}_1^a)(1-\alpha)\alpha(b_s\beta_s-\theta\beta_q)}{\hat{z}(\beta_q^2+\beta_s^2)(2+\alpha(\hat{\beta}_1^b-1))(1+\alpha\hat{\beta}_1^a)}=\bar{p}_1. \qquad Q.E.D.$$

**Proof of Corollary 3**

Let $E_i[FP^*]=E[\tilde{x}_1^*]+E[\tilde{x}_2^*]$ denote the equilibrium financial performance when $s=s_i^*$ and $q^*=q_i^*$, with $i=\{3,4a,4b\}$ and expectations are taken from the perspective of $t=0$. For bullet point (i) of Corollary 3, $E_{4a}[FP^*]-E_3[FP^*]>0$ needs to hold. Note that $E_{4a}[FP^*]-E_3[FP^*]>0$ simplifies to:

$$\frac{2p\hat{z}}{2(1+\alpha\hat{\beta}_1^a)^2}(2p(\beta_q^2+\beta_s^2)(2-\hat{z}+2\alpha\hat{\beta}_1^a)+2\alpha(1+\hat{\beta}_1^a)(b_s\beta_s-\theta\beta_q))>0.$$

Since $2-\hat{z}+2\alpha\hat{\beta}_1^a>0$ because $\hat{z}\in(0,1)$, the inequality above is always satisfied when $b_s\beta_s>\theta\beta_q$, which provides the first condition in bullet point (i) of Corollary 3. When $b_s\beta_s<\theta\beta_q$, $2p(\beta_q^2+\beta_s^2)(2-\hat{z}+2\alpha\hat{\beta}_1^a)>2\alpha(1+\hat{\beta}_1^a)(\theta\beta_q-b_s\beta_s)$ needs to hold, which leads to the second condition in bullet point (i) of Corollary 3:

$$p>\frac{\alpha(1+\hat{\beta}_1^a)(\theta\beta_q-b_s\beta_s)}{(\beta_q^2+\beta_s^2)(2-\hat{z}+2\alpha\hat{\beta}_1^a)}=\bar{p}_2.$$

For bullet point (ii) of Corollary 3, $E_{4b}[FP^*]-E_3[FP^*]>0$ needs to hold when $\theta=b_s$ and $\beta_q=\beta_s$. Under these assumptions, $E_{4b}[FP^*]-E_3[FP^*]>0$ simplifies to:

$$p^2\gamma_1+\gamma_2>0 \text{ where:}$$

$$\gamma_1=\underbrace{2\hat{z}(\beta_q+\alpha\hat{\beta}_1^a\beta_q)^2(2-\alpha+\alpha\hat{\beta}_1^b)(2(2-\hat{z}+2\alpha\hat{\beta}_1^b)+\hat{z}\alpha(1-\hat{\beta}_1^b))}_{>0 \text{ since } \alpha,\hat{\beta}_1^b,\hat{z}\in(0,1)}$$

$$\gamma_2=\underbrace{2\theta^2\alpha^2(\alpha-1)(\hat{\beta}_1^b-\hat{\beta}_1^a)(2+(\hat{\beta}_1^a+\hat{\beta}_1^b)(1+\alpha)+2\alpha\hat{\beta}_1^a\hat{\beta}_1^b)}_{<0 \text{ since } \alpha\in(0,1) \text{ and } \hat{\beta}_1^b>\hat{\beta}_1^a}.$$

The following inequality thus needs to hold:

$$p > \sqrt{\frac{-\gamma_2}{\gamma_1}}$$

$$= \sqrt{\frac{\theta^2\alpha^2(1-\alpha)(\hat{\beta}_1^b - \hat{\beta}_1^a)(2 + (\hat{\beta}_1^a + \hat{\beta}_1^b)(1+\alpha) + 2\alpha\hat{\beta}_1^a\hat{\beta}_1^b)}{\hat{z}(\beta_q + \alpha\hat{\beta}_1^a\beta_q)^2(2-\alpha+\alpha\hat{\beta}_1^b)(2(2-\hat{z}+2\alpha\hat{\beta}_1^b) + \hat{z}\alpha(1-\hat{\beta}_1^b))}} = \bar{p}_3.$$

Since $p > 0$ needs to hold, only the positive root of the above term is a feasible solution. *Q.E.D.*

**Derivation of the Market Prices in Section 4.3**

If $\Phi_1^I = \{x_1, y, I\}$, $\tilde{x}_1 = \tilde{R} - \tilde{C} + p(\hat{z}_0 + \hat{z}y)$, and $\tilde{x}_2 = \tilde{R} + \tilde{B}_s + pI$, the stock price $\tilde{P}_1$ equals:

$$E[\tilde{x}_2|x_1, y, I] = E[\tilde{R} + \tilde{B}_s + pI|x_1, y, I].$$

Because $E[p\tilde{I}|x_1, y, I] = pI$, this equals:

$$E[\tilde{x}_2|x_1, y, I] = E[\tilde{R} + \tilde{B}_s|x_1, y, I] + pI.$$

After the investors' conjectures of $\hat{q}$ and $\hat{s}$, $E[\tilde{R} + \tilde{B}_s|x_1, y, I]$ is given by:

$$E[\tilde{R} + \tilde{B}_s|x_1, y, I] = E[\hat{R} + \hat{B}_s] +$$

$$\begin{bmatrix}\mathrm{Cov}(\tilde{R} + \tilde{B}_s, \tilde{x}_1) & \mathrm{Cov}(\tilde{R} + \tilde{B}_s, \tilde{y}) & \mathrm{Cov}(\tilde{R} + \tilde{B}_s, \tilde{I})\end{bmatrix} \begin{bmatrix}\mathrm{Var}(\tilde{x}_1) & \mathrm{Cov}(\tilde{x}_1, \tilde{y}) & \mathrm{Cov}(\tilde{x}_1, \tilde{I}) \\ \mathrm{Cov}(\tilde{x}_1, \tilde{y}) & \mathrm{Var}(\tilde{y}) & \mathrm{Cov}(\tilde{y}, \tilde{I}) \\ \mathrm{Cov}(\tilde{x}_1, \tilde{I}) & \mathrm{Cov}(\tilde{y}, \tilde{I}) & \mathrm{Var}(\tilde{I})\end{bmatrix}^{-1} \begin{bmatrix}x_1 - E[\hat{x}_1] \\ y - E[\hat{y}] \\ I - E[\hat{I}]\end{bmatrix}$$

Moreover, because of the independence assumption of random variables: $\mathrm{Cov}(\tilde{R} + \tilde{B}_s, \tilde{x}_1) = \sigma_{\tilde{r}}^2$, $\mathrm{Cov}(\tilde{R} + \tilde{B}_s, \tilde{y}) = 0$, $\mathrm{Cov}(\tilde{R} + \tilde{B}_s, \tilde{I}) = 0$, $\mathrm{Cov}(\tilde{x}_1, \tilde{y}) = p\hat{z}(\sigma_{\tilde{i}}^2 + \sigma_{\tilde{\varepsilon}}^2)$, $\mathrm{Cov}(\tilde{y}, \tilde{I}) = \sigma_{\tilde{i}}^2$, $\mathrm{Cov}(\tilde{x}_1, \tilde{I}) = p\hat{z}\sigma_{\tilde{i}}^2$, $\mathrm{Var}(\tilde{x}_1) = \sigma_{\tilde{r}}^2 + \sigma_{\tilde{\gamma}}^2 + (p\hat{z})^2(\sigma_{\tilde{i}}^2 + \sigma_{\tilde{\varepsilon}}^2)$, $\mathrm{Var}(\tilde{y}) = \sigma_{\tilde{i}}^2 + \sigma_{\tilde{\varepsilon}}^2$, and $\mathrm{Var}(\tilde{I}) = \sigma_{\tilde{i}}^2$. After matrix algebra $E[\tilde{R} + \tilde{B}_s|x_1, y, I]$ simplifies to:

$$E[\tilde{R} + \tilde{B}_s|x_1, y, I] = E[\hat{R} + \hat{B}_s] + \hat{\beta}_1^c(x_1 - E[\hat{x}_1]) - p\hat{z}\hat{\beta}_1^c(y - E[\hat{y}])$$

where $\hat{\beta}_1^c = \hat{\beta}_1^a = \frac{\sigma_{\tilde{r}}^2}{\sigma_{\tilde{r}}^2+\sigma_{\tilde{\gamma}}^2}$ and $\hat{z} = \frac{\sigma_{\tilde{i}}^2}{\sigma_{\tilde{i}}^2+\sigma_{\tilde{\varepsilon}}^2}$. Hence:

$$\tilde{P}_1 = E[\tilde{x}_2|x_1, y, I] = E[\hat{R} + \hat{B}_s] + \hat{\beta}_1^c(x_1 - E[\hat{x}_1]) - p\hat{z}\hat{\beta}_1^c(y - E[\hat{y}]) + pI =$$

$$\tilde{P}_1 = \hat{\beta}_0^c + \hat{\beta}_1^c x_1 + \hat{\beta}_2^c y + \hat{\beta}_3^c I$$

$$\text{where: } \hat{\beta}_0^c = E[\hat{R}] + E[\hat{B}_s] - \hat{\beta}_1^c E[\hat{x}_1] + p\hat{z}\hat{\beta}_1^c E[\hat{y}]$$

$$\hat{\beta}_1^c = \hat{\beta}_1^a = \frac{\sigma_{\tilde{r}}^2}{\sigma_{\tilde{r}}^2 + \sigma_{\tilde{\gamma}}^2},$$

$$\hat{\beta}_2^c = -p\hat{z}\hat{\beta}_1^c,$$

$$\text{and } \hat{\beta}_3^c = p.$$

If $\Phi_1^I = \{x_1, I\}$, the stock price $\tilde{P}_1$ equals:

$$E[\tilde{x}_2|x_1, I] = E[\tilde{R} + \tilde{B}_s + pI|x_1, I].$$

Using properties of conditional expectations and the fact that $pE[\tilde{I}|x_1, I] = pI$, this simplifies to:

$$E[\tilde{x}_2|x_1, I] = E[\tilde{R} + \tilde{B}_s|x_1, I] + pI.$$

Moreover, since $\tilde{R}$, $\tilde{B}_s$, $\tilde{x}_1$, and $\tilde{I}$ are affected by $q$ and $s$, investors need to form conjectures of $\hat{q}$ and $\hat{s}$. Given these conjectures, $E[\tilde{R} + \tilde{B}_s|x_1, I]$ equals:

$$E[\tilde{R} + \tilde{B}_s|x_1, I] =$$

$$E[\hat{R} + \hat{B}_s] + \begin{bmatrix} \mathrm{Cov}(\tilde{R} + \tilde{B}_s, \tilde{x}_1) & \mathrm{Cov}(\tilde{R} + \tilde{B}_s, \tilde{I}) \end{bmatrix} \begin{bmatrix} \mathrm{Var}(\tilde{x}_1) & \mathrm{Cov}(\tilde{x}_1, \tilde{I}) \\ \mathrm{Cov}(\tilde{x}_1, \tilde{I}) & \mathrm{Var}(\tilde{I}) \end{bmatrix}^{-1} \begin{bmatrix} x_1 - E[\hat{x}_1] \\ I - E[\hat{I}] \end{bmatrix}$$

Applying matrix algebra yields:

$$E[\tilde{R} + \tilde{B}_s|x_1, I] = E[\hat{R} + \hat{B}_s] + \hat{\beta}_1^d(x_1 - E[\hat{x}_1]) - p\hat{z}\hat{\beta}_1^d(I - E[\hat{I}])$$

where $\hat{\beta}_1^d = \frac{\sigma_{\tilde{r}}^2}{\sigma_{\tilde{r}}^2+\sigma_{\tilde{\gamma}}^2+\sigma_{\tilde{\varepsilon}}^2(p\hat{z})^2}$ and $\hat{z} = \frac{\sigma_{\tilde{i}}^2}{\sigma_{\tilde{i}}^2+\sigma_{\tilde{\varepsilon}}^2}$. Substituting $E[\tilde{R}+\tilde{B}_s|x_1,I]$ into the equation for $E[\tilde{x}_2|x_1,I]$ results in the stock price:

$$\tilde{P}_1 = E[\tilde{x}_2|x_1,I] = E[\hat{R}+\hat{B}_s] + \hat{\beta}_1^d(x_1 - E[\hat{x}_1]) - p\hat{z}\hat{\beta}_1^d(I - E[\hat{I}]) + pI =$$

$$\tilde{P}_1 = \hat{\beta}_0^d + \hat{\beta}_1^d x_1 + \hat{\beta}_2^d I$$

$$\text{where: } \hat{\beta}_0^d = E[\hat{R}] + E[\hat{B}_s] - \hat{\beta}_1^d E[\hat{x}_1] + p\hat{z}\hat{\beta}_1^d E[\hat{I}],$$

$$\hat{\beta}_1^d = \frac{\sigma_{\tilde{r}}^2}{\sigma_{\tilde{r}}^2 + \sigma_{\tilde{\gamma}}^2 + \sigma_{\tilde{\varepsilon}}^2(p\hat{z})^2},$$

$$\text{and } \hat{\beta}_2^d = p(1 - \hat{z}\hat{\beta}_1^d). \qquad Q.E.D.$$

**Proof of Corollary 4**

Bullet point (i) of Corollary 4 follows from the fact that $\forall\ \hat{z} \in [0,1)$ numerator of $s_{5a}^*$ ($q_{5a}^*$) is strictly larger (smaller) than the numerator of $s_{4a}^*$ ($q_{4a}^*$), albeit the denominator is the same because $\hat{\beta}_1^a = \hat{\beta}_1^c$. Hence, $s_{5a}^* > s_{4a}^*$ and $q_{5a}^* < q_{4a}^*$ and environmental performance is always better when there is disclosure of $\tilde{I}$. Bullet point (ii) requires that $E[\tilde{I}]$ is higher when $s^* = s_{5b}^*$ and $q^* = q_{5b}^*$ rather than $s^* = s_{4b}^*$ and $q^* = q_{4b}^*$, i.e. $E_{5b}[\tilde{I}] - E_{4b}[\tilde{I}] > 0$. $E_{5b}[\tilde{I}] - E_{4b}[\tilde{I}] > 0$ simplifies to:

$$p\gamma_3 + \alpha(\hat{\beta}_1^b - \hat{\beta}_1^d)(1-\alpha)(b_s\beta_s - \theta\beta_q) > 0 \text{ where:}$$

$$\gamma_3 = \underbrace{(\beta_q^2 + \beta_s^2)(1 - \hat{z} + \alpha(\hat{\beta}_1^b - \hat{z}\hat{\beta}_1^d) + \hat{z}\alpha(1 - \hat{\beta}_1^d) + \hat{z}\alpha^2\hat{\beta}_1^d(1 - \hat{\beta}_1^b)).}_{>0 \text{ since } \hat{\beta}_1^b > \hat{\beta}_1^d \text{ and } \hat{z}, \hat{\beta}_1^b, \hat{\beta}_1^d \in (0,1)}$$

Because $\hat{\beta}_1^b > \hat{\beta}_1^d$ and $\alpha \in (0,1)$, $p\gamma_3 + \alpha(\hat{\beta}_1^b - \hat{\beta}_1^d)(1-\alpha)(b_s\beta_s - \theta\beta_q) > 0$ always holds when $b_s\beta_s > \theta\beta_q$. Alternatively, when $b_s\beta_s < \theta\beta_q$, $p\gamma_3 + \alpha(\hat{\beta}_1^b - \hat{\beta}_1^d)(1-\alpha)(b_s\beta_s - \theta\beta_q) > 0$ holds when:

$$p > \frac{\alpha(\hat{\beta}_1^b - \hat{\beta}_1^d)(1-\alpha)(\theta\beta_q - b_s\beta_s)}{(\beta_q^2 + \beta_s^2)(1 - \hat{z} + \alpha(\hat{\beta}_1^b - \hat{z}\hat{\beta}_1^d) + \hat{z}\alpha(1 - \hat{\beta}_1^d) + \hat{z}\alpha^2\hat{\beta}_1^d(1 - \hat{\beta}_1^b))} = \bar{p}_4.$$

For bullet point (iii), $E[\tilde{I}]$ needs to be higher when $s^* = s_{5b}^*$ and $q^* = q_{5b}^*$ rather than $s^* = s_{5a}^*$ and $q^* = q_{5a}^*$, i.e. $E_{5b}[\tilde{I}] - E_{5a}[\tilde{I}] > 0$ needs to hold. $E_{5b}[\tilde{I}] - E_{5a}[\tilde{I}] > 0$ simplifies to:

$$p(\beta_q^2 + \beta_s^2)(1 + \hat{z}) + (1-\alpha)(b_s\beta_s - \theta\beta_q) > 0.$$

This holds always when $b_s\beta_s > \theta\beta_q$ or, in case $b_s\beta_s < \theta\beta_q$, if:

$$p > \frac{(1-\alpha)(\theta\beta_q - b_s\beta_s)}{(\beta_q^2+\beta_s^2)(1+\hat{z})} = \bar{p}_5.$$

*Q.E.D.*

**Derivation of the Thresholds in Figures 3a and 3b**

In Figure 3a, $s^*_{5b} > s^*_{4b}$ follows from the fact that the numerator and denominator of $s^*_{5b}$ are larger and smaller than those of $s^*_{4b}$, respectively. Furthermore, $q^*_{5b} - q^*_{4b}$ simplifies to:

$$\alpha(\hat{\beta}_1^b - \hat{\beta}_1^d)(1-\alpha)\theta - p\beta_q(1-\hat{z}+\alpha(\hat{\beta}_1^b - \hat{z}\hat{\beta}_1^d) + \hat{z}\alpha(1-\hat{\beta}_1^d) + \hat{z}\alpha^2\hat{\beta}_1^d(1-\hat{\beta}_1^b)).$$

For $q^*_{5b} - q^*_{4b} > 0$, the following hence needs to be satisfied:

$$p < \frac{\alpha(\hat{\beta}_1^b - \hat{\beta}_1^d)(1-\alpha)\theta}{\beta_q(1-\hat{z}+\alpha(\hat{\beta}_1^b - \hat{z}\hat{\beta}_1^d) + \hat{z}\alpha(1-\hat{\beta}_1^d) + \hat{z}\alpha^2\hat{\beta}_1^d(1-\hat{\beta}_1^b))} = \bar{p}_{t1}.$$

For $\Delta q > \Delta s$, $q^*_{5b} - q^*_{4b} - (s^*_{5b} - s^*_{4b}) > 0$ needs to hold, which is equivalent to:

$$\alpha(\hat{\beta}_1^b - \hat{\beta}_1^d)(1-\alpha)(\theta - b_s) -$$
$$p(\beta_q+\beta_s)(1-\hat{z}+\alpha(\hat{\beta}_1^b - \hat{z}\hat{\beta}_1^d) + \hat{z}\alpha(1-\hat{\beta}_1^d) + \hat{z}\alpha^2\hat{\beta}_1^d(1-\hat{\beta}_1^b)) > 0.$$

The inequality above follows from substituting the equilibrium investment levels into $q^*_{5b} - q^*_{4b} - (s^*_{5b} - s^*_{4b}) > 0$ and simplifying results. Solving for $p$ yields that the inequality is satisfied when:

$$p < \frac{\alpha(\hat{\beta}_1^b - \hat{\beta}_1^d)(1-\alpha)(\theta - b_s)}{(\beta_q+\beta_s)(1-\hat{z}+\alpha(\hat{\beta}_1^b - \hat{z}\hat{\beta}_1^d) + \hat{z}\alpha(1-\hat{\beta}_1^d) + \hat{z}\alpha^2\hat{\beta}_1^d(1-\hat{\beta}_1^b))} = \bar{p}_{t2}.$$

Since $p > 0$ needs to hold, the additional requirement that $b_s < \theta$ arises. In Figure 3b, $s^*_{5b} > s^*_{5a}$ holds because both $s^*_{5b}$ and $s^*_{5a}$ have the same numerator but the denominator of $s^*_{5a}$ is larger than that of $s^*_{5b}$. Moreover, $q^*_{5b} - q^*_{5a} > 0$ simplifies to:

$$(1-\alpha)\theta - p(1+\hat{z})\beta_q > 0.$$

$q^*_{5b} - q^*_{5a} > 0$ therefore holds when:

$$p < \frac{(1-\alpha)\theta}{(1+\hat{z})\beta_q} = \bar{p}_{t3}.$$

Furthermore, $q^*_{5b} - q^*_{5a} - (s^*_{5b} - s^*_{5a}) > 0$ is equivalent to:

$$(1-\alpha)(\theta - b_s) - p(1+\hat{z})(\beta_q + \beta_s) > 0.$$

Hence, in this case, for $\Delta q > \Delta s$ to hold the following has to be satisfied:

$$p < \frac{(1-\alpha)(\theta - b_s)}{(1+\hat{z})(\beta_q + \beta_s)} = \bar{p}_{t4}.$$

Again, for $p > 0$, $b_s < \theta$ has to hold. *Q.E.D.*

**Proof of Corollary 5**

As above, let $E_i[FP^*]$ denote the equilibrium financial performance when $s = s^*_i$ and $q^* = q^*_i$, with $i = \{4a, 4b, 5a, 5b\}$. Expectations are taken, again, at $t = 0$. For bullet point (i) of Corollary 5, $E_{5a}[FP^*] - E_{4a}[FP^*] > 0$ needs to hold, which is equivalent to:

$$p(\beta_q^2 + \beta_s^2)(4\alpha\hat{\beta}_1^a + 3(1-\hat{z})) + 2\alpha(1+\hat{\beta}_1^a)(b_s\beta_s - \theta\beta_q) > 0.$$

This holds always when $b_s\beta_s > \theta\beta_q$. Moreover, when $b_s\beta_s < \theta\beta_q$, the inequality is satisfied when:

$$p > \frac{2\alpha(1+\hat{\beta}_1^a)(\theta\beta_q - b_s\beta_s)}{(\beta_q^2 + \beta_s^2)(4\alpha\hat{\beta}_1^a + 3(1-\hat{z}))} = \bar{p}_6.$$

Bullet point (ii) of Corollary 5 requires that $E_{5b}[FP^*] - E_{4b}[FP^*] > 0$ when $\theta = b_s$ and $\beta_q = \beta_s$. Under these assumptions, $E_{5b}[FP^*] - E_{4b}[FP^*] > 0$ simplifies to:

$$\gamma_4 + \gamma_5\gamma_6 > 0 \text{ where}$$

$$\gamma_4 = \underbrace{b_s^2\alpha^2(\hat{\beta}_1^b - \hat{\beta}_1^d)(1-\alpha)(2 + (\hat{\beta}_1^b + \hat{\beta}_1^d)(1+\alpha) + 2\hat{\beta}_1^b\hat{\beta}_1^d\alpha)}_{>0 \text{ since } \hat{\beta}_1^b > \hat{\beta}_1^d \text{ and } \alpha \in (0,1)}$$

$$\gamma_5 = \underbrace{p^2\beta_q(\hat{z} - 1 + \hat{z}\alpha(\hat{\beta}_1^d - 1) + \alpha(\hat{\beta}_1^d\hat{z} - \hat{\beta}_1^b) + \hat{\beta}_1^d\hat{z}\alpha^2(\hat{\beta}_1^b - 1))}_{<0 \text{ since } \hat{\beta}_1^b > \hat{\beta}_1^d \text{ and } \hat{z}, \hat{\beta}_1^b, \hat{\beta}_1^d \in (0,1)}$$

$$\gamma_6 = \underbrace{(\hat{z} - 1)(3 + 2\hat{\beta}_1^b\alpha) + \hat{z}\alpha(\hat{\beta}_1^d - 1) + \alpha(\hat{\beta}_1^d\hat{z} - \hat{\beta}_1^b) + \hat{\beta}_1^d\hat{z}\alpha^2(\hat{\beta}_1^b - 1)}_{<0 \text{ since } \hat{\beta}_1^b > \hat{\beta}_1^d \text{ and } \hat{z}, \hat{\beta}_1^b, \hat{\beta}_1^d \in (0,1)}$$
$$-(4\hat{\beta}_1^b\hat{\beta}_1^d\alpha^2 + 4\hat{\beta}_1^d\alpha).$$

Since $\gamma_4 > 0$ and both $\gamma_5$ and $\gamma_6 < 0$, $E_{5b}[FP^*] - E_{4b}[FP^*] > 0$ holds always when $\theta = b_s$ and $\beta_q = \beta_s$. Bullet point (iii) requires that $E_{5b}[FP^*] - E_{5a}[FP^*] > 0$ when $\theta = b_s$ and $\beta_q = \beta_s$, or equivalently:

$$\gamma_7 + \gamma_8 > 0 \text{ where}$$

$$\gamma_7 = \underbrace{2b_s^2(1-\alpha)\alpha(2 + (\hat{\beta}_1^a + \hat{\beta}_1^d)(1+\alpha) + 2\hat{\beta}_1^a\hat{\beta}_1^d\alpha)}_{>0 \text{ since } \alpha \in (0,1)}$$

$$\gamma_8 = \underbrace{2p^2\beta_q^2(1+\hat{z})(2(1-\hat{z}) + (\hat{\beta}_1^d\alpha + \hat{\beta}_1^a\alpha)(2-\hat{z}) + (\hat{\beta}_1^d + \hat{\beta}_1^a)\alpha + 4\hat{\beta}_1^d\hat{\beta}_1^a\alpha^2)}_{>0 \text{ since } \hat{z} \in (0,1)}.$$

Since $\gamma_7$ and $\gamma_8 > 0$, $E_{5b}[FP^*] - E_{5a}[FP^*] > 0$ is always satisfied when $\theta = b_s$ and $\beta_q = \beta_s$.

*Q.E.D.*

**Proof of Corollary 7**

Corollary 7 examines $\frac{\partial\hat{\beta}_1^d}{\partial\sigma_{\tilde{r}}}$, $\frac{\partial\hat{\beta}_1^d}{\partial\sigma_{\tilde{i}}}$, $\frac{\partial\hat{\beta}_1^d}{\partial p}$, $\frac{\partial\hat{\beta}_1^d}{\partial\sigma_{\tilde{\gamma}}}$ and $\frac{\partial\hat{\beta}_1^d}{\partial\sigma_{\tilde{\varepsilon}}}$, where $\hat{\beta}_1^d = \frac{\sigma_{\tilde{r}}^2}{\sigma_{\tilde{r}}^2 + \sigma_{\tilde{\gamma}}^2 + \sigma_{\tilde{\varepsilon}}^2(p\hat{z})^2}$ and $\hat{z} = \frac{\sigma_{\tilde{i}}^2}{\sigma_{\tilde{i}}^2 + \sigma_{\tilde{\varepsilon}}^2}$.

$$\frac{\partial\hat{\beta}_1^d}{\partial\sigma_{\tilde{r}}} = \frac{2\sigma_{\tilde{r}}(\sigma_{\tilde{\varepsilon}}^2 + \sigma_{\tilde{i}}^2)^2((\sigma_{\tilde{\varepsilon}}^2 + \sigma_{\tilde{i}}^2)^2\sigma_{\tilde{\gamma}}^2 + \sigma_{\tilde{\varepsilon}}^2\sigma_{\tilde{i}}^4p^2)}{(\sigma_{\tilde{\varepsilon}}^4(\sigma_{\tilde{\gamma}}^2 + \sigma_{\tilde{r}}^2) + \sigma_{\tilde{i}}^4(\sigma_{\tilde{\gamma}}^2 + \sigma_{\tilde{r}}^2) + \sigma_{\tilde{\varepsilon}}^2\sigma_{\tilde{i}}^2(2\sigma_{\tilde{\gamma}}^2 + \sigma_{\tilde{i}}^2p^2 + 2\sigma_{\tilde{r}}^2))^2} > 0,$$

$$\frac{\partial\hat{\beta}_1^d}{\partial\sigma_{\tilde{i}}} = -\frac{4p^2\sigma_{\tilde{r}}^2\sigma_{\tilde{\varepsilon}}^4\sigma_{\tilde{i}}^3(\sigma_{\tilde{\varepsilon}}^2 + \sigma_{\tilde{i}}^2)}{(\sigma_{\tilde{\varepsilon}}^4(\sigma_{\tilde{\gamma}}^2 + \sigma_{\tilde{r}}^2) + \sigma_{\tilde{i}}^4(\sigma_{\tilde{\gamma}}^2 + \sigma_{\tilde{r}}^2) + \sigma_{\tilde{\varepsilon}}^2\sigma_{\tilde{i}}^2(2\sigma_{\tilde{\gamma}}^2 + \sigma_{\tilde{i}}^2p^2 + 2\sigma_{\tilde{r}}^2))^2} < 0,$$

$$\frac{\partial \hat{\beta}_1^d}{\partial p} = -\frac{2p\sigma_{\tilde{r}}^2\sigma_{\tilde{\varepsilon}}^2\sigma_{\tilde{i}}^4(\sigma_{\tilde{\varepsilon}}^2+\sigma_{\tilde{i}}^2)^2}{(\sigma_{\tilde{\varepsilon}}^4(\sigma_{\tilde{\gamma}}^2+\sigma_{\tilde{r}}^2)+\sigma_{\tilde{i}}^4(\sigma_{\tilde{\gamma}}^2+\sigma_{\tilde{r}}^2)+\sigma_{\tilde{\varepsilon}}^2\sigma_{\tilde{i}}^2(2\sigma_{\tilde{\gamma}}^2+\sigma_{\tilde{i}}^2p^2+2\sigma_{\tilde{r}}^2))^2} < 0,$$

$$\frac{\partial \hat{\beta}_1^d}{\partial \sigma_{\tilde{\gamma}}} = -\frac{2\sigma_{\tilde{\gamma}}\sigma_{\tilde{r}}^2(\sigma_{\tilde{\varepsilon}}^2+\sigma_{\tilde{i}}^2)^4}{(\sigma_{\tilde{\varepsilon}}^4(\sigma_{\tilde{\gamma}}^2+\sigma_{\tilde{r}}^2)+\sigma_{\tilde{i}}^4(\sigma_{\tilde{\gamma}}^2+\sigma_{\tilde{r}}^2)+\sigma_{\tilde{\varepsilon}}^2\sigma_{\tilde{i}}^2(2\sigma_{\tilde{\gamma}}^2+\sigma_{\tilde{i}}^2p^2+2\sigma_{\tilde{r}}^2))^2} < 0,$$

$$\text{and} \quad \frac{\partial \hat{\beta}_1^d}{\partial \sigma_{\tilde{\varepsilon}}} = \frac{2p^2\sigma_{\tilde{r}}^2\sigma_{\tilde{\varepsilon}}\sigma_{\tilde{i}}^4}{(\sigma_{\tilde{\varepsilon}}^4(\sigma_{\tilde{\gamma}}^2+\sigma_{\tilde{r}}^2)+\sigma_{\tilde{i}}^4(\sigma_{\tilde{\gamma}}^2+\sigma_{\tilde{r}}^2)+\sigma_{\tilde{\varepsilon}}^2\sigma_{\tilde{i}}^2(2\sigma_{\tilde{\gamma}}^2+\sigma_{\tilde{i}}^2p^2+2\sigma_{\tilde{r}}^2))^2}(\sigma_{\tilde{\varepsilon}}^4-\sigma_{\tilde{i}}^4).$$

Hence, $\frac{\partial \hat{\beta}_1^d}{\partial \sigma_{\tilde{r}}} > 0$, $\frac{\partial \hat{\beta}_1^d}{\partial \sigma_{\tilde{i}}} < 0$, $\frac{\partial \hat{\beta}_1^d}{\partial p} < 0$, $\frac{\partial \hat{\beta}_1^d}{\partial \sigma_{\tilde{\gamma}}} < 0$, and the sign of $\frac{\partial \hat{\beta}_1^d}{\partial \sigma_{\tilde{\varepsilon}}}$ depends on the sign of $(\sigma_{\tilde{\varepsilon}}^4-\sigma_{\tilde{i}}^4)$. *Q.E.D.*

# Appendix B

**Manager with Intrinsic Preferences for Strong ESG Performance**

In this setting, the manager's utility increases directly with $\tilde{I}$, where $\lambda_M > 0$ captures the extent with which a given positive environmental impact increases the manager's utility. If a manager's remuneration is tied to an environmental key performance indicator, or the manager just prefers to direct an environmentally friendly company, then $\lambda_M > 0$ holds. At $t = 0$, the manager makes investment decisions to maximize the following expected utility function:

$$\max_{\mathbf{q},\mathbf{s}} \; E[U_0|\Phi_0^{\mathrm{M}}] = E[\tilde{x}_1|\Phi_0^{\mathrm{M}}] + \alpha E[\tilde{P}_1|\Phi_0^{\mathrm{M}}] + (1-\alpha)E[\tilde{x}_2|\Phi_0^{\mathrm{M}}] + \lambda_M E[\tilde{I}|\Phi_0^{\mathrm{M}}] \tag{11}$$

I consider the case where there is an imprecise signal about $\tilde{I}$, i.e. $\tilde{y} = \tilde{I} + \tilde{\varepsilon}$, at $t = 0.5$ and disclosure of $\tilde{I}$ at $t = 1$. The stakeholders' expectation of the firm's environmental impact is hence given by: $E[\tilde{I}|\Phi_{0.5}^{ST}] = E[\tilde{I}|y] = \hat{z}_0 + \hat{z}y$ at $t = 0.5$, where $\hat{z}_0 = E[\hat{I}] - \hat{z}E[\hat{y}]$ and $\hat{z} = \frac{\sigma_{\tilde{i}}^2}{\sigma_{\tilde{i}}^2+\sigma_{\tilde{\varepsilon}}^2}$, and $E[\tilde{I}|\Phi_1^{ST}] = I$ at $t = 1$. It follows that the firm's short- and long-run financial performance is $\tilde{x}_1 = \tilde{R} - \tilde{C} + p(\hat{z}_0 + \hat{z}y)$ and $\tilde{x}_2 = \tilde{R} + \tilde{B}_s + pI$, respectively, leading to the manager's expectations of $\tilde{x}_1$ and $\tilde{x}_2$:

$$E[\tilde{x}_1|\Phi_0^M] = \theta q - \frac{q^2}{2} - \frac{s^2}{2} + p(\hat{z}_0 + \hat{z}(\beta_s s - \beta_q q)) \text{ and}$$

$$E[\tilde{x}_2|\Phi_0^M] = \theta q + b_s s + p(\beta_s s - \beta_q q)$$

The market's valuation of the firm's long-run financial performance, i.e. $\tilde{P}_1 = E[\tilde{x}_2|\Phi_1^I]$, varies with the information set of investors:

$$\tilde{P}_1 = \hat{\beta}_0^c + \hat{\beta}_1^c x_1 + \hat{\beta}_2^c y + \hat{\beta}_3^c I \quad \text{if} \quad \Phi_1^I = \{x_1, y, I\}$$
$$\text{and} \quad \tilde{P}_1 = \hat{\beta}_0^d + \hat{\beta}_1^d x_1 + \hat{\beta}_2^d I \quad \text{if} \quad \Phi_1^I = \{x_1, I\}$$

Details of these calculations are in section "Derivation of the Market Prices in Section 4.3" in Appendix A. It follows that the manager's expectation of the market valuation is given by:

$$E[\tilde{P}_1|\Phi_0^{\mathrm{M}}] = \hat{\beta}_1^c(\theta q - \frac{q^2}{2} - \frac{s^2}{2}) + p(\beta_s s - \beta_q q) + \hat{k}^c \quad \text{if} \quad \Phi_1^I = \{x_1, y, I\}$$
$$\text{and} \quad E[\tilde{P}_1|\Phi_0^{\mathrm{M}}] = \hat{\beta}_1^d(\theta q - \frac{q^2}{2} - \frac{s^2}{2}) + p(\beta_s s - \beta_q q) + \hat{k}^d \quad \text{if} \quad \Phi_1^I = \{x_1, I\}$$

where $\hat{k}^c = \hat{\beta}_0^c + p\hat{z}_0\hat{\beta}_1^c$ and $\hat{k}^d = \hat{\beta}_0^d + p\hat{z}_0\hat{\beta}_1^d$ are the same additive constants as in section 4.3 that do not affect $s^*$ or $q^*$ (because they are zero when taking the first order derivative of the utility function w.r.t. to $q$ and $s$.) Finally, since the manager has intrinsic preferences for a higher $\tilde{I}$, to solve the manager's utility maximization problem the expectation $E[\tilde{I}|\Phi_0^{\mathrm{M}}]$ has to be evaluated:

$$E[\tilde{I}|\Phi_0^{\mathrm{M}} = s, q] = \beta_s s - \beta_q q$$

Substituting $E[\tilde{x}_1|\Phi_0^M], E[\tilde{x}_2|\Phi_0^M], E[\tilde{P}_1|\Phi_0^M]$, and $E[\tilde{I}|\Phi_0^{\mathrm{M}}]$ into the manager's utility function and taking the first order conditions w.r.t. $q$ and $s$ yields the equilibrium investments:

$$s_{\lambda a}^* = \frac{b_s(1-\alpha) + p\beta_s(1+\hat{z}) + \lambda_M \beta_s}{1+\alpha\hat{\beta}_1^c} \quad \textit{and} \quad q_{\lambda a}^* = \frac{\theta(2-\alpha+\alpha\hat{\beta}_1^c) - p\beta_q(1+\hat{z}) - \lambda_M\beta_q}{1+\alpha\hat{\beta}_1^c}$$
$$\textit{if} \quad \Phi_1^I = \{x_1, y, I\}.$$
$$s_{\lambda b}^* = \frac{b_s(1-\alpha) + p\beta_s(1+\hat{z}) + \lambda_M \beta_s}{1+\alpha\hat{\beta}_1^d} \quad \textit{and} \quad q_{\lambda b}^* = \frac{\theta(2-\alpha+\alpha\hat{\beta}_1^d) - p\beta_q(1+\hat{z}) - \lambda_M\beta_q}{1+\alpha\hat{\beta}_1^d}$$
$$\textit{if} \quad \Phi_1^I = \{x_1, I\}.$$

The equilibrium investments are identical to those in Proposition 5, except that there is an additional increase in sustainability investments $s^*$ by $\frac{\lambda_M \beta_s}{1+\alpha\hat{\beta}_1}$ and a decrease in environmentally harmful $q^*$ by $\frac{\lambda_M \beta_q}{1+\alpha\hat{\beta}_1}$. The change in investments reflects that the manager intrinsically cares about strong environmental performance. Although this adaption of the main model "shifts" the company towards a more environmentally friendly business, the main effects and inference of disclosing $\tilde{I}$ are qualitatively unchanged: ESG-interested stakeholders more strongly react to more precise information of $\tilde{I}$, the stock price positively reacts to a higher $\tilde{I}$ because a higher $\tilde{I}$ is associated with better long-run financial performance, and disclosure changes the market price's sensitivity to $\tilde{x}_1$ because e.g. investors need not infer indirect long-run financial performance from $\tilde{x}_1$.

**Investors with Intrinsic Preferences for Strong ESG Performance**

This section studies altruistic investors that not only care about ESG performance because it affects financial performance, but have direct preferences for better nonfinancial outcomes. In this case, rather then $\tilde{P}_1 = E[\tilde{x}_2|\Phi_1^{\mathrm{I}}]$, the stock price is given by:

$$\tilde{P}_1 = E[\tilde{x}_2|\Phi_1^{\mathrm{I}}] + \lambda_I E[\tilde{I}|\Phi_1^{\mathrm{I}}] \tag{12}$$

$\lambda_I > 0$ gauges the influence of investors with altruistic preferences and who directly value $\tilde{I}$ on the stock price. If non-investor stakeholders observe $\tilde{y} = \tilde{I} + \tilde{\varepsilon}$ at $t = 0.5$ and there is public disclosure of $\tilde{I}$ at $t = 1$, $E[\tilde{I}|\Phi_{0.5}^{ST}] = E[\tilde{I}|y] = \hat{z}_0 + \hat{z}y$ at $t = 0.5$, where $\hat{z}_0 = E[\hat{I}] - \hat{z}E[\hat{y}]$ and $\hat{z} = \frac{\sigma_{\tilde{i}}^2}{\sigma_{\tilde{i}}^2 + \sigma_{\tilde{\varepsilon}}^2}$, and $E[\tilde{I}|\Phi_1^{ST}] = I$ at $t = 1$. As a result, $E[\tilde{x}_2|\Phi_1^{\mathrm{I}}]$ is again equal to $E[\tilde{x}_2|\Phi_1^{\mathrm{I}}] = \hat{\beta}_0^c + \hat{\beta}_1^c x_1 + \hat{\beta}_2^c y + \hat{\beta}_3^c I$ if $\Phi_1^I = \{x_1, y, I\}$ and $E[\tilde{x}_2|\Phi_1^{\mathrm{I}}] = \hat{\beta}_0^d + \hat{\beta}_1^d x_1 + \hat{\beta}_2^d I$ if $\Phi_1^I = \{x_1, I\}$. Moreover, because there is *public* disclosure of ESG performance, investors also observe $\tilde{I}$ and $\lambda_I E[\tilde{I}|\Phi_1^{\mathrm{I}}] = \lambda_I I$. The overall stock price is thus given by:

$$\begin{aligned} \tilde{P}_1 &= \hat{\beta}_0^c + \hat{\beta}_1^c x_1 + \hat{\beta}_2^c y + \hat{\beta}_3^c I + \lambda_I I \quad \text{if} \quad \Phi_1^I = \{x_1, y, I\} \\ \text{and} \quad \tilde{P}_1 &= \hat{\beta}_0^d + \hat{\beta}_1^d x_1 + \hat{\beta}_2^d I + \lambda_I I \quad \text{if} \quad \Phi_1^I = \{x_1, I\} \end{aligned}$$

It follows that:

$$\begin{aligned} E[\tilde{P}_1|\Phi_0^{\mathrm{M}}] &= \hat{\beta}_1^c(\theta q - \frac{q^2}{2} - \frac{s^2}{2}) + (p + \lambda_I)(\beta_s s - \beta_q q) + \hat{k}^c \quad \text{if} \quad \Phi_1^I = \{x_1, y, I\} \\ \text{and} \quad E[\tilde{P}_1|\Phi_0^{\mathrm{M}}] &= \hat{\beta}_1^d(\theta q - \frac{q^2}{2} - \frac{s^2}{2}) + (p + \lambda_I)(\beta_s s - \beta_q q) + \hat{k}^d \quad \text{if} \quad \Phi_1^I = \{x_1, I\} \end{aligned}$$

where $\hat{k}^c = \hat{\beta}_0^c + p\hat{z}_0\hat{\beta}_1^c$ and $\hat{k}^d = \hat{\beta}_0^d + p\hat{z}_0\hat{\beta}_1^d$ are the same additive constants as in the previous section. Substituting $E[\tilde{x}_1|\Phi_0^M], E[\tilde{x}_2|\Phi_0^M]$, and $E[\tilde{P}_1|\Phi_0^M]$ into the manager's utility function and solving the manager's utility maximization problem yields:

$$s^*_{\lambda c} = \frac{b_s(1-\alpha) + p\beta_s(1+\hat{z}) + \lambda_I \alpha \beta_s}{1+\alpha\hat{\beta}_1^c} \quad and \quad q^*_{\lambda c} = \frac{\theta(2-\alpha+\alpha\hat{\beta}_1^c) - p\beta_q(1+\hat{z}) - \lambda_I \alpha \beta_q}{1+\alpha\hat{\beta}_1^c}$$

$$if \ \ \Phi_1^I = \{x_1, y, I\}.$$

$$s^*_{\lambda d} = \frac{b_s(1-\alpha) + p\beta_s(1+\hat{z}) + \lambda_I \alpha \beta_s}{1+\alpha\hat{\beta}_1^d} \quad and \quad q^*_{\lambda d} = \frac{\theta(2-\alpha+\alpha\hat{\beta}_1^d) - p\beta_q(1+\hat{z}) - \lambda_I \alpha \beta_q}{1+\alpha\hat{\beta}_1^d}$$

$$if \ \ \Phi_1^I = \{x_1, I\}.$$

The results are very similar to the setting where the manager has intrinsic preferences for strong ESG performance. The manager invests more in $s$ and less in $q$ by $\frac{\lambda_I \alpha \beta_s}{1+\alpha\hat{\beta}_1}$ and $\frac{\lambda_I \alpha \beta_q}{1+\alpha\hat{\beta}_1}$, respectively, compared to when investors do not intrinsically care about nonfinancial performance. The reason is that there is an additional increase in $\tilde{P}_1$ for better nonfinancial performance: investors not only react positively to a higher $\tilde{I}$ because of its financial benefits, but also because they altruistically care about nonfinancial performance. The manager's actions result in a more environmentally friendly business, but the main effects of mandatory ESG disclosure remain unaltered.

## All Business Activities Have Positive Environmental Externalities

In the main part of the paper, I focus on the setting where the firm's positive environmental impact increases in $s$ and decreases in $q$. That is, $\tilde{I} = \beta_s s - \beta_q q + \tilde{i}$ with $\beta_s > 0$ and $\beta_q > 0$. If the main business activity had a positive environmental impact, then $\beta_q < 0$ holds and the firm's positive environmental impact increases in $q$. In this case, stakeholder pressure for strong ESG performance would lead to an increase in $q$. Consider for example the equilibrium of Proposition 5: $q^*_{5a} = \frac{\theta(2-\alpha+\alpha\hat{\beta}_1^c) - p\beta_q(1+\hat{z})}{1+\alpha\hat{\beta}_1^c}$ $\ if \ \ \Phi_1^I = \{x_1, y, I\}, \ \ or \ \ q^*_{5b} = \frac{\theta(2-\alpha+\alpha\hat{\beta}_1^c) - p\beta_q(1+\hat{z})}{1+\alpha\hat{\beta}_1^c} \ \ if \ \ \Phi_1^I = \{x_1, I\}$. If the main business activity had a positive environmental impact and hence $\beta_q < 0$, the terms $-p\beta_q(1+\hat{z})$ and $-p\beta_q(1+\hat{z})$ are positive and the manager boosts $q$ because of stakeholder pressure for strong ESG performance. Disclosure of $\tilde{I}$ still leads to a stakeholder-, direct stock price-, and signal-jamming effect, but can never lead to worse ESG performance. The reason is that the increase in $q$ following changes in signal-jamming incentives also enhances ESG performance. The model thus suggests if all business activities had positive environmental externalities, mandatory ESG disclosure is environmentally beneficial.

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