Disclosure Standards for Corporate Social Responsibility*

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Abstract

Modern firms are increasingly investing in corporate social responsibility (CSR) activities and follow various disclosure standards to demonstrate their CSR investments to stakeholders. While some disclosure policies allow firms to fully disclose their CSR engagements, others adopt a simplified approach that assigns firms into several discrete categories (e.g., A to D) based on their level of engagement. Such policies appear to reduce the information content of the disclosure, which may seem less meaningful or useful. In this paper, we develop an analytical model of CSR disclosure to understand how firms invest in CSR under different disclosure standards. Our analysis shows that, when firms' CSR engagements are endogenously determined, a discrete disclosure policy incentivizes certain firms to overinvest in CSR, ultimately benefiting society as a whole. This research guides public policymakers on how best to design CSR disclosure standards and determines materiality thresholds that allow certain levels of investments to be disclosed. Additionally, our findings help firms make optimal CSR investments.

Keywords: Corporate social responsibility, disclosure, investment, public policy, stakeholder

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1 Introduction

Across various industries and regions, modern firms are placing increased emphasis on corporate social responsibility (CSR), establishing objectives beyond profit maximization and engaging in efforts that enhance the welfare of multiple stakeholders. Such activities range from investments into environmentally friendly production processes, the recruitment of responsible suppliers, the enhancement of employee benefits, and the support of disadvantaged groups (Liang and Renneboog, 2017). Every year, Fortune 500 companies spend approximately $20 billion on CSR activities (Iglesias, 2022).

CSR has garnered significant attention from government bodies, employees, suppliers, investors, and consumers alike. It has been found that 70% of Americans believe it is somewhat or very important for firms to make the world a better place (Stobierski, 2015), and consumers support brands that contribute to the greater societal good, which incentivizes firms to engage in CSR (Hughes, 2017). Bauman and Skitka (2012) suggest that CSR increases organizational pride, employee satisfaction, and in-role performance.

Given these benefits, various government regulations and initiatives have been proposed to mandate investments into CSR or, at the very least, encourage firms to disclose and report their CSR activities. India's Companies Act 2013 is an example of aggressive legislation that mandates large companies to spend at least 2% of their average net profits on CSR activities. Meanwhile, the European Union's Non-Financial Reporting Directive takes a milder approach, requiring large public-interest companies with more than 500 employees only to disclose information on environmental, social, and governance (ESG) matters in their annual reports. The United Kingdom's Companies Act 2006 similarly requires firms to report the impact of their business on environmental, social, community, and human rights issues. It's no surprise then that, in 2024, KPMG (2024) surveyed the world's top 250 companies and found that 96% reported on sustainability and 95% published a carbon target. The Governance & Accountability Institute found that nearly all S&P500 disclosed their CSR activities, with 98.6% publishing a report in 2023.[1]

[1]See the article: "G&A Institute's Research Shows 2023 Sustainability Reporting at Record Levels as U.S. Public

These increasingly prevalent CSR disclosures vary in format. Common disclosure standards, such as the Global Reporting Initiative (GRI), Sustainable Accounting Standards Board (SASB) and the proposed climate-related disclosure rules by the Securities and Exchange Commission (SEC), offer detailed and standardized frameworks for reporting CSR activities. However, governments and in particular third-party organizations often adopt a simplified approach to measure and disclose CSR performance: instead of distributing detailed information on individual firms' CSR engagement, they simply classify firms into several categories or ratings based on their CSR activities.

High-quality CSR disclosures are known to bring benefits such as increased liquidity, lower cost of capital, access to public debt markets, and improved investor perceptions and intentions (Stuart et al., 2022). At first glance, the disclosure would be expected to be of higher quality when it contains quantitative information regarding CSR engagement, which raises the question of why so many entities adopt simplified disclosure policies that contain only qualitative information or coarse information such as categories or ratings (Bowman and Haire, 1976; Shane and Spicer, 1983).

In this paper, we develop an analytical model to study the effect that disclosure standards have on firms' CSR investments. We consider a market consisting of firms that are heterogeneous in their marginal returns to CSR.[2] The firms invest in CSR efforts and then disclose this information to stakeholders following a disclosure standard chosen by a public policymaker who values both firm profits and CSR and thus seeks to strike a balance between the two. In line with typical practice, we consider three types of disclosure standards: (i) nondisclosure, under which firms do not disclose any information regarding their CSR investments; (ii) full disclosure, under which firms disclose the exact amount of their CSR investments; and (iii) discrete disclosure, under which firms only disclose whether or not their CSR investment passes a pre-specified threshold set according to public policy. We then compare equilibrium outcomes under the three disclosure

Companies Prepare for Mandated Disclosure" (2024 September).

[2] An alternative interpretation is that firms have investors with heterogeneous CSR preferences who value CSR investments differently.

standards to examine their impacts on firm profits and social welfare.

Our model yields several noteworthy findings. First, while firms do not invest in CSR under the nondisclosure regime, they invest efficiently under the full disclosure regime. This is because unobservable allocations into CSR require stakeholders to form conjectures about those allocations; since such conjectures are fixed, firms have no reason to make costly investments into CSR and thus rationally choose to forgo such investments. Interestingly, under discrete disclosure, the disclosure decision becomes binary: firms either invest at exactly the threshold level or do not invest at all. The reason is that, if a firm's investment does not cross the threshold, stakeholders retain their fixed conjectures regarding firm value, which causes the firm to not invest at all. Once the firm meets the threshold and this information is disclosed, stakeholders correctly surmise that the firm invests at the threshold level, and the firm has no reason to invest beyond that level.

We further find that both underinvesting and overinvesting can occur under discrete disclosure, depending on the firm's marginal return to CSR investment. Because a firm's investment strategy is binary, it either distorts its investment level *downward* to zero to avoid costly (and unobserved) expenditures into CSR or *upward* to the disclosure threshold to then signal this qualification to stakeholders. When its marginal return to CSR is low, the firm prefers downward distortion and, therefore, underinvests in CSR. When its marginal return to CSR is high (but not too high), the firm prefers upward distortion and, therefore, overinvests in CSR.

Second, we find that disclosure standards significantly impact the payoff of public policymakers. When the policymaker is primarily concerned with firm profits, they always prefer full disclosure to discrete disclosure; however, when they are primarily concerned with CSR, they always prefer discrete disclosure to full disclosure. This is because, by strategically choosing a disclosure threshold, the public policymaker can induce more firms to overinvest (or underinvest less) in CSR activities, thereby generating a higher aggregate CSR investment. Though the firms are worse off making suboptimal investment decisions, the policymaker is overall better off due to more CSR investments. As such, detailed disclosure policies are not always better, and pub-

lic policymakers are recommended to set strategic disclosure standards to induce their desired outcomes. This finding also justifies regulatory reliance on discrete CSR/ESG ratings, especially when addressing firms that underinvest in CSR.

Finally, we consider two extensions to discrete disclosure: multiple levels of discrete disclosure and censored disclosure. Under multiple levels of discrete disclosure, the public policymaker establishes categories based on the level of CSR investment and discloses which category a firm belongs to. Under censored disclosure, the public policymaker sets a disclosure threshold below which nothing is disclosed. When a firm's investment exceeds this threshold, however, the policymaker discloses the exact amount the firm invested in CSR activities.

We show that both multiple levels of discrete disclosure and censored disclosure encourage firms to invest more in CSR and improve the public policymaker's payoff. A censored disclosure policy justifies the materiality threshold emphasized by those standardizing CSR/ESG disclosures at the forefront: disclose only when the amount of investment is significant (i.e., material enough) and is consistent with, e.g., the European Union (EU) taxonomy for sustainable activities that requires disclosing specific green investments that qualify as "environmentally sustainable", i.e., meet certain sustainable thresholds.

Our results provide novel empirical and regulatory implications. In particular, we show that even when CSR investments can be measured precisely, a regulator that cares sufficiently about the magnitudes of such investments may prefer discrete or partial disclosure to induce overinvestment in CSR activities. Our result also justifies disclosing CSR investments only if they surpass some materiality threshold (e.g., Khan et al. 2016 and Grewal et al. 2019). Finally, we have the counterintuitive policy implication that when policymakers care more about CSR, they should increase the disclosure threshold such that less firms will disclose but those who disclose will overinvest more in CSR. The intuition of those implications depends on the subtle interaction between the regulator's chosen disclosure policy and firms' strategic behavior in response to such disclosure policy that we discuss in more detail in the main text.

The rest of the paper is organized as follows. After reviewing related literature, Section 2

introduces the model, which is solved in Section 3. Sections 4 and 5 study the two extensions to discrete disclosure. Section 6 discusses model implications. Section 7 concludes our work.

Related Literature Our paper contributes to several streams of literature, the first of which relates to the growing body of work on the economic consequences of CSR/ESG disclosures.[3] Our paper most closely relates to the real effects of such disclosure. For example, Mahieux et al. (2025) study how mandating greenhouse gas emissions (GHGs) disclosure can result in emissions leakages while Xue (2023) shows how measuring the outcome of ESG investments can discipline firm investments that have both cash flow and ESG impact. Friedman et al. (2024) study the interaction between ESG reports and financial reports and how they may discipline managers' unobservable investment/effort decisions.

Our paper focuses on how discrepancy between a public policymaker and a firm (which may fail to fully account for the positive externalities of their CSR investment) may be a reason for the policymaker to use mandatory disclosure regulations to encourage CSR commitments. Different from Friedman et al. (2024), we focus exclusively on CSR disclosures, and, differing from Mahieux et al. (2025) and Xue (2023), we measure unobservable CSR investments rather than the outcomes of those investments, rendering the issue of measurement precision moot, as it is well-known in the real effects literature that noisy measures of any endogenous decision lacks information content, e.g., Matthews and Mirman (1983); Kanodia et al. (2005).

We nevertheless show that imperfect disclosure in the form of discrete or censored disclosure can be optimal in maximizing social welfare; in this sense, our study's focus on the disclosure of ex-ante CSR investments has notably different implications when compared to those of literature that measures ex-post CSR outcomes. Our findings are also aimed to be more implementable: While valuable, precisely measuring certain ex-post outcomes (e.g., level 3 GHGs) may be extremely challenging, whereas it is more manageable to precisely measure ex-ante investments (e.g., amount invested into green technologies that aim to reduce GHGs) and, if beneficial, implement imprecise measures or thresholds (e.g., discrete ratings based on a firm's level of investment

[3] See Grewal et al. (2020), Christensen et al. (2021), and Friedman and Ormazabal (2024) for excellent reviews.

into green technologies).

Second, our results on the optimality of censored disclosure (i.e., full disclosure if and only if the CSR investment is above a certain threshold) are related to the materiality threshold widely discussed in CSR/ESG disclosures (e.g., Khan et al., 2016; Jebe, 2019). While the materiality threshold is usually referred to as "relevant to investor decision-making," in our model, it relates to the magnitude of the investment, which aligns it more closely to the materiality threshold considered in financial accounting (e.g., separately disclosing items that are of sufficient magnitude). To the extent that this magnitude reflects how important CSR is to a firm and/or its stakeholders, it can also be considered relevant to investor decision-making. Note that such a materiality threshold can only be generated through a discrete disclosure rule rather than signal plus noise in the usual continuous disclosure setting. This result is also consistent with investor responses and, in turn, stock prices responding to investor information, as documented by Moss et al. (2022).

Thirdly, our results that a threshold-based disclosure rule will induce firms' manipulation around threshold is related to the "classifications manipulation" literature (e.g., Dye (2002),Gao (2013),Gao and Jiang (2020)). While Gao (2013) and Gao and Jiang (2020) emphasize the importance of ex-ante earnings manipulation, in our setting firms manipulate their CSR investments ex post around the threshold set up ex ante, similar to Dye (2002). However, Dye (2002) focuses on the difference between the "official standard" and "shadow standard" conditional on the threshold-based standard, whereas we focus on comparing discrete standards and continuous standards, as in Gao and Jiang (2020).

Finally, our study of a disclosure strategy that suppresses information through discrete intervals connects to the well-known optimal disclosure results discussed in the cheap talk literature (e.g., Crawford and Sobel, 1982; Morgan and Stocken, 2003). However, cheap talk models are ex-post disclosure models that assume zero lying cost, whereas we focus on ex-ante disclosure rules that implicitly require a firm's commitment. In cheap talk models, information is suppressed to prevent the receiver from taking advantage of the sender's message and ultimately making real decisions that may hurt the sender; meanwhile, in our setting, information is suppressed to

change the sender's real decisions to benefit the receiver.

2 The Model

2.1 Firms

There is a continuum of firms of unit measure (i.e., on $[0, 1]$), and each firm makes an investment in CSR.[4] For instance, a power plant can invest in new technologies to reduce its carbon emissions, a tech company can offer technological access to underserved communities, an agricultural goods manufacturer can improve the livelihoods of small farmer suppliers. We use $s_i \geq 0$ to denote firm i's CSR investment, with a higher s_i denoting more CSR engagement. A firm's investment is not directly observed by other stakeholders in the market, given that it is generally difficult for the public to assess, for instance, if and/or how much a power plant is utilizing green technology in its production.

We assume that a firm is concerned only about its monetary payoff. Nonetheless, it can indirectly benefit from its CSR investments through a reputation effect, i.e., being recognized as a socially responsible organization can enhance brand image and trust amongst stakeholders and reduce the cost of capital. For instance, being seen as a socially responsible organization can enhance brand image and trust in the company and reduce the firm's cost of capital.[5] Becker-Olsen et al. (2006) find that consumers reward firms even for profit-motivated CSR initiatives, and Khan et al. (2016) empirically show that firms with good sustainability ratings significantly outperform those with poor ratings.

To capture these effects, we assume that a firm enjoys a monetary payoff of $\alpha_i \cdot \hat{s}_i$ for its CSR investments, where $\alpha_i \geq 0$ captures the firm's marginal benefit from the CSR investment and $\hat{s}_i$ is its stakeholders' belief regarding the firm's level of CSR investment, which is specified later and

[4] Our model can also apply to other types of investment—such as research and development—that generate externalities valued by the regulator but potentially ignored by firms. CSR investment is our leading example.

[5] CSR may bring other monetary benefits to the company, e.g., reduce energy consumption if investments are made into this area. While we do not focus on these effects, our main results continue to hold in their presence.

generally depends on the firm's CSR disclosure. One example of the stakeholders is investors, as their perception of firms' CSR investments determines firms' valuation and thus their payoffs. In practice, firms are often heterogeneous in how much they benefit from CSR, with some benefiting more than others. For the example of investors, this can stem from investors' heterogeneous CSR preferences. Isaksson and Woodside (2016) suggest that firms with strong management benefit more from CSR activities than those with poor management. In line with this observation, we assume that firm i privately observes its marginal return to CSR, α_i, which stakeholders perceive to be uniformly distributed between L and H, where $H > L \geq 0$, i.e., $\alpha_i \sim U[L, H]$. For the remainder of the paper, we normalize $H = 1$ without loss of generality.

When investing in CSR, firms incur a cost, which we assume is $s_i^2/2$. As noted by Wang and Bansal (2012), the more resources a firm allocates to CSR activities, the fewer resources remain available to improve its core business. Such a quadratic function captures decreasing marginal returns to CSR investment, e.g., it becomes increasingly costly for a power plant to develop and implement better technologies to reduce carbon emissions. Therefore, firm i's payoff from its CSR investment is

$$\pi_i = \alpha_i \cdot \hat{s}_i - \frac{s_i^2}{2}.$$

Note that we do not emphasize any of the firm's additional payoffs since they are not the focus of our present paper

2.2 Public Policymaker

The model consists of a public policymaker who is concerned with CSR. More specifically, the policymaker benefits from higher CSR levels as CSR typically exerts positive externalities to multiple stakeholders. For instance, CSR efforts aim to reduce pollution, improve workplace safety, and enhance product quality to benefit the well-being of society as a whole, which is in line with the policymaker's objective.

While caring about CSR investments, the public policymaker is also concerned about firm payoffs. This is because i) increased firm profits result in more taxes collected, ii) a higher firm payoff from CSR investments makes CSR activities more sustainable and yields long-term benefits to society, and iii) higher firm profits are typically associated with higher salaries and consumption and lower unemployment rates.

Following the above discussion, we adopt the following specification to model the policymaker's objective:[6]

$$\Pi = \beta \int s_i di + (1 - \beta) \int \pi_i di, \tag{1}$$

where $0 \leq \beta \leq 1$ is the weight placed on CSR and $1 - \beta$ is the weight placed on firms' payoffs. In this specification, $\int \pi_i di$ is the aggregate profit of all firms in the economy, and $\int s_i d_i$ is the aggregate CSR activities conducted by all firms in the economy, which collectively demonstrate that the public policymaker is concerned with both CSR and firm profits and strikes a balance between the two. In the extreme case of $\beta = 0$, the policymaker is concerned only about firms' payoffs, and, when $\beta = 1$, they are concerned only about CSR.

2.3 Disclosure

As previously discussed, a firm's CSR investment is not directly observed by other stakeholders unless such information is certified and disclosed according to disclosure standards designed by public policy. In line with real-life business practice, we consider the following three disclosure regimes: nondisclosure (N), full disclosure (F), and discrete disclosure (D, or category disclosure). We explore other potential disclosure policies in extensions. Let I_i be the information disclosed by firm i.

- **Nondisclosure**: Under nondisclosure, a firm's CSR investment is always withheld (i.e.,

[6] This welfare function weights CSR positively by assumption. We do not model how CSR investment translates into measurable social benefits; instead, we treat the parameter β as a reduced-form representation of the social value generated by CSR investment.

$I_i^N = \emptyset$ for all firms), so that stakeholders do not receive any additional information regarding the firms' CSR investment beyond the prior. We use superscript N to denote nondisclosure.

Note that there are no regulations preventing firms from voluntarily disclosing their CSR activities. However, in the absence of certification and verification, such disclosure becomes cheap talk and does not carry any informational weight, rendering it equivalent to nondisclosure. In other words, voluntary disclosure without verifiable information is equivalent to no disclosure. [7]

- **Full disclosure**: Under full disclosure, firm i truthfully discloses its CSR investment (i.e., $I_i^F = s_i$ for all firms),[8] and there is no information asymmetry between the firm and its stakeholders. Under guidance such as the Sustainability Accounting Standards Board (SASB) standards, firms are allowed to voluntarily disclose their sustainability information and, if they so choose, firms always truthfully disclose their entire CSR activities, thus facilitating full disclosure. In real-life practice, the rating agency EcoVadis assigns an EcoVadis score (0–100), which reflects the quality of a firm's sustainability management and is largely in line with full disclosure.[9] We use superscript F to denote full disclosure.

- **Discrete disclosure**: Under discrete disclosure, a public policymaker sets a disclosure threshold, δ^D. If a firm's CSR investment is below this threshold, nothing is disclosed. If the investment is equal to or greater than the threshold, the policymaker certifies and discloses that the firm has a high CSR investment. Mathematically, the disclosure policy can be written as

$$I_i^D = \begin{cases} \emptyset & \text{if } \ s_i < \delta^D, \\ \text{High} & \text{if } \ s_i \geq \delta^D. \end{cases} \tag{2}$$

[7] See Jiang et al. (2023) for a discussion on the importance of certification in facilitating the efficiency of unobservable investments, particularly CSR investments.

[8] While a firm can also choose not to disclose, according to the unravelling principle, nondisclosure is treated as no CSR investment and is dominated by disclosure.

[9] https://support.ecovadis.com/hc/en-us/articles/210460227-Understanding-EcoVadis-Medals-and-Badges

As discussed later, the policymaker can decide on the threshold δ^D to maximize their objective.

Discrete disclosure policies are widely adopted in practice. For instance, the nonprofit organization B Lab Global offers B Corporation Certifications to firms that meet a minimum score on the B Impact Assessment, which evaluates social and environmental performance.[10] Fairtrade International, a nonprofit that advocates for farmers and workers through fair trade, also certifies products that have been manufactured according to fair trade standards.[11] Furthermore, public policymakers often adopt multiple discrete levels of disclosure, such as by rating a firm's CSR as good, satisfactory, or non-satisfactory (e.g., the red/yellow/green "traffic-light" system used by the eToro platform).[12] We discuss further in Section 4 and show that allowing multiple levels of disclosure only strengthens our results.

As explained earlier, because stakeholders do not observe s_i directly, they rely on available information and form expectations about firm i's CSR investments. We thus can rewrite the firm's payoff as

$$\pi_i = \alpha_i E[s_i|I_i] - \frac{s_i^2}{2},$$

where $E[s_i|I_i]$ is stakeholders' expectation of the firm's CSR investment given the information disclosed. When making inferences, stakeholders apply the Bayes' rule whenever applicable.

2.4 Sequence of Moves

The game unfolds in three stages. In the first stage, the public policymaker chooses between a nondisclosure, full disclosure, or discrete disclosure regime. If they choose discrete disclosure, they also choose the disclosure threshold, δ^D, which is publicly observable to the market. In

[10] https://www.bcorporation.net/en-us/certification/

[11] https://www.fairtrade.net/en/why-fairtrade/how-we-do-it/how-does-the-label-work/how-fairtrade-certification-works.html

[12] See https://www.etoro.com/investing/esg/ for more details.

the second stage, each firm makes its CSR investment decision and discloses according to the disclosure policy chosen by the policymaker in the first stage. In the third stage, stakeholders take the information disclosed and infer each firm's CSR investment, and firm profits are realized.

3 Model Analysis

In this section, we analyze the equilibrium outcome under the three disclosure regimes. Then, we compare their equilibrium outcomes to derive the public policymaker's optimal disclosure policy.

3.1 Nondisclosure

Under the nondisclosure regime, no firms disclose, and, as such, all are indistinguishable to stakeholders who hold the same belief about their CSR investments. Let $\hat{s}_i^N$ be the stakeholders' common belief regarding firm i's CSR investment, which is a constant. Firm i thus chooses a CSR investment s_i^N to maximize its payoff

$$\pi_i^N = \alpha_i \cdot \hat{s}_i^N - \frac{(s_i^N)^2}{2}.$$

It follows immediately that firm profit is maximized at $s_i^N = 0$. Lemma 1 summarizes this discussion:

Lemma 1 (Nondisclosure)**.** *Under the nondisclosure regime, no firm invests in CSR, i.e.,* $s_i^N = 0$*. In equilibrium, all firms make zero profits, and the public policymaker's payoff is* $\Pi^N = 0$*.*

Because firms cannot disclose any information regarding their CSR investments, stakeholders always hold the same belief regardless of the actual amount or level invested. In other words, investing in CSR does not change stakeholders' beliefs, so firms have no incentive to invest; furthermore, in equilibrium, stakeholders also hold the rational belief that firms will not invest. As a result, the whole market breaks down with no CSR activities being conducted. This lemma suggests that disclosure is needed to incentivize firms to invest in CSR.

3.2 Full Disclosure

Under the full disclosure regime, all firms truthfully disclose their exact CSR investment s_i^F, leaving no information asymmetry between them and their stakeholders, i.e., $\hat{s}_i^F = s_i^F$. As such, firm i makes its CSR investment decision s_i^F to maximize its payoff

$$\pi_i^F = \alpha_i \cdot s_i^F - \frac{(s_i^F)^2}{2}.$$

It follows immediately that, by choosing $s_i^F = \alpha_i$, firm i's profit is maximized at $\alpha_i^2/2$. Given the firms' optimal strategies, the aggregate CSR investment and aggregate firm profit are respectively (note we normalized $H = 1$):

$$\Delta^F = \int_L^1 \alpha_i dF(\alpha_i) = \frac{1+L}{2}, \;\; \pi^F = \int_L^1 \frac{\alpha_i^2}{2} dF(\alpha_i) = \frac{1+L+L^2}{6}.$$

The following lemma summarizes the result.

Lemma 2 (Full disclosure). *Under the full disclosure regime, firm i chooses $s_i^F = \alpha_i$, and makes a profit of $\pi_i^F = \frac{\alpha_i^2}{2}$. The public policymaker's payoff is $\Pi^F = \frac{\beta(1+L)}{2} + \frac{(1-\beta)(1+L+L^2)}{6}$.*

Lemma 2 shows that, compared to nondisclosure, full disclosure restores some market efficiency, leading to both higher firm profits and CSR investments. In this sense, the public policymaker strictly prefers full disclosure over nondisclosure.

3.3 Discrete Disclosure

Under the discrete disclosure regime, the public policymaker chooses a disclosure threshold δ^D and certifies and discloses whether or not a firm's CSR investment passes this threshold. Because there are only two disclosed states, we use $\hat{s}_L^D = E[\hat{s}_i^D | I^D = \emptyset]$ and $\hat{s}_H^D = E[s_i^D | I^D = \text{High}]$ to denote stakeholders' belief regarding firm i's CSR investment when the disclosure threshold is met and not met, respectively. In equilibrium, the conjecture must be consistent with the firm's

equilibrium investment decision. It directly follows from the definition of the threshold that $\hat{s}_H^D \geq \delta^D > \hat{s}_L^D$.

Taking δ^D as given, each firm makes its CSR investment decision to maximize its profit, s_i^D. Firm i effectively chooses between the following two strategies: (1) It makes a low investment $s_i^D < \delta^D$. In this case, the firm's payoff is $\pi_i^D = \alpha_i \hat{s}_L^D - \frac{(s_i^D)^2}{2}$. (2) It makes a high investment $s_i^D \geq \delta^D$. In this case, the firm's payoff is $\pi_i^D = \alpha_i \hat{s}_H^D - \frac{(s_i^D)^2}{2}$. The following lemma characterizes the firms' investment decision.

Lemma 3 (Investment under discrete disclosure)**.** *In equilibrium, firm i's investment must satisfy that $s_i^D \in \{0, \delta^D\}$.*

Following Lemma 3, because stakeholders' beliefs must be consistent with the firms' equilibrium investment decisions, $\hat{s}_L^D = 0$ and $\hat{s}_H^D = \delta^D$. To maximize its payoff, firm i compares its two investment choices (i.e., $s_i^D \in \{0, \delta^D\}$), which reveals that its investment decision also follows a threshold strategy:

$$s_i^D = \begin{cases} 0 & \text{if } \alpha_i < \frac{\delta^D}{2}, \\ \delta^D & \text{otherwise.} \end{cases} \tag{3}$$

Intuitively, if firm i's investment does not exceed the threshold, stakeholders hold a fixed belief regarding the investment made. Similar to nondisclosure, the only consistent conjecture stakeholders make is that firm i will not/does not invest; thus, in equilibrium, firm i does not invest. When firm i's investment exceeds the threshold, stakeholders again hold a fixed, but higher, belief regarding the investment. Firm i does not invest beyond the conjectured level, given that additional investments are costly and do not come without additional benefits. In equilibrium, when α_i is sufficiently large, the capital market benefit of investing at a higher level outweighs the cost, so firm i chooses to invest a higher level.

3.4 The Effect of Discrete Disclosure on Firms' CSR Investment

Thus far, we've derived the firms' equilibrium disclosure decisions under three different regimes. We now compare the firms' CSR investment under full and discrete disclosure and summarize the results in the following proposition:

Proposition 1 (Investment under discrete disclosure versus full disclosure)**.** *Compared to full disclosure, under discrete disclosure, a firm invests more in CSR when* $\frac{\delta^D}{2} \leq \alpha_i < \delta^D$ *and invests less otherwise.*

Proposition 1 uncovers a key finding that a firm can invest more in CSR under discrete disclosure. Under full disclosure, regardless of the amount or level invested, the firm can perfectly communicate this information to its stakeholders. Under discrete disclosure, however, as illustrated in Lemma 3, the firm only has two options: (1) to not invest in CSR at all, i.e., $s_i^D = 0$, or (2) to make a high investment in CSR, i.e., $s_i^D = \delta^D$. When $\alpha_i > \delta^D$, the firm distorts its investment downward to δ^D. When $0 \leq s_i^F = \alpha_i < \delta^D$, the firm distorts its investment either downward to $s_i^D = 0$ or upward to $s_i^D = \delta^D$. Overall, a mass of firms equal to $1 - \frac{\delta^D}{2}$ underinvest, while the remaining mass $\frac{\delta^D}{2}$ overinvest.[13] As the regulator endogenously sets the threshold (to be discussed shortly), she can choose it strategically so that the distortion from overinvestment outweighs that from underinvestment, and thus firms end up investing more under discrete disclosure.

We illustrate this result using the following numerical example: $\alpha_i = 0.5$ and $\delta^D = 0.8$. Under full disclosure, the firm chooses an optimal investment level $s_i^F = 0.5$, making a profit of $\pi_i^F = 0.125$. Under discrete disclosure, the firm either cuts its investment to $s_i^D = 0$ for a payoff of $\pi_i^D = 0$ or increases its investment to $s_i^D = \delta^D = 0.8$ for a payoff of $\pi_i^D = 0.08$. Comparing these two strategies, the firm chooses to invest more.

Taken together, Proposition 1 implies that public policymakers can strategically use discrete disclosure policies as a tool to influence and incentivize (some) firms' investment decisions.

[13] We assess over- or under-investment under discrete disclosure relative to the investment chosen under full disclosure. Alternatively, one could benchmark against the investment that maximizes the regulator's objective function (1). Comparing with this alternative benchmark does not make any qualitative difference.

Following this discussion, we can immediately derive the policymaker's payoff as follows:

$$\Pi^D = \begin{cases} \frac{\delta^D(1+\beta+(1-\beta)(L-\delta^D))}{2} & \text{if } \delta^D < 2L, \\ \frac{\delta^D(2-\delta^D)(2+2\beta-\delta^D+\beta\delta^D)}{8(1-L)} & \text{if } 2L \leq \delta^D \leq 2, \\ 0 & \text{if } \delta^D > 2. \end{cases} \tag{4}$$

In Equation (4), when $\delta^D < 2L$, the threshold for disclosure is too low, and all firms make high CSR investments (i.e., $s_i^D = \delta^D$) to enjoy the benefit of CSR. When $\delta^D > 2$, the threshold is too high for firms to invest, and thus they do not invest in CSR at all (i.e., $s_i^D = 0$). Lastly, when the disclosure threshold δ^D is moderate, firms with lower marginal returns to CSR (i.e., $\alpha_i \leq \frac{\delta^D}{2}$) choose not to invest while firms with higher marginal returns to CSR (i.e., $\alpha_i > \frac{\delta^D}{2}$) choose to invest and enjoy the ensuing benefits.

3.5 Public Policymaker's Optimal Decision for δ^D

Following our discussion on the equilibrium outcome given the disclosure threshold δ^D, we now work backward to investigate the public policymaker's optimal decision for δ^D. Following Equation (4), the public policymaker chooses between the following options:

(1) Low threshold $\delta^D < 2L$: In this case, the policymaker's payoff is $\Pi^D = \frac{\delta^D(1+\beta+(1-\beta)(L-\delta^D))}{2}$. Solving their maximization problem, we find that their payoff is maximized at

$$\delta^D = \min\left(2L, \frac{1+\beta}{2(1-\beta)} + \frac{L}{2}\right). \tag{5}$$

(2) Moderate threshold $2L \leq \delta^D \leq 2$: In this case, policymaker's payoff is $\Pi^D = \frac{\delta^D(2-\delta^D)(2+2\beta-\delta^D+\beta\delta^D)}{8(1-L)}$. Solving their maximization problem, we find that their payoff is maximized at

$$\delta^D = \max\left(2L, \frac{4-2\sqrt{1+3\beta^2}}{3(1-\beta)}\right). \tag{6}$$

(3) High threshold $\delta^D \geq 2$: In this case, the policymaker's payoff is always 0.

Comparing the policymaker's payoff under these scenarios, we arrive at the following proposition:

Proposition 2 (Optimal threshold under discrete disclosure)**.** *Under discrete disclosure, the public policymaker's optimal decision on δ^D is as follows: When $L \leq 0.5$,*

$$\delta^{D*} = \begin{cases} \frac{1+\beta+L-L\beta}{2(1-\beta)} & \text{if } \beta \leq \frac{3L-1}{1+3L}, \\ 2L & \text{if } \frac{3L-1}{1+3L} < \beta < \frac{1-4L+3L^2}{3L^2-1}, \\ \frac{4-2\sqrt{1+3\beta^2}}{3(1-\beta)} & \text{otherwise.} \end{cases} \tag{7}$$

When $L \geq 0.5$,

$$\delta^{D*} = \begin{cases} \frac{1+\beta+L-L\beta}{2(1-\beta)} & \text{if } \beta \leq \frac{3L-1}{1+3L}, \\ 2L & \text{otherwise.} \end{cases} \tag{8}$$

Proposition 2 characterizes the optimal threshold given L and β. For a given L, the optimal disclosure threshold increases with β. This result is intuitive. As β increases, the policymaker cares more about CSR and thus is more willing to tolerate overinvestments. Correspondingly, the policymaker sets δ^D to be higher.

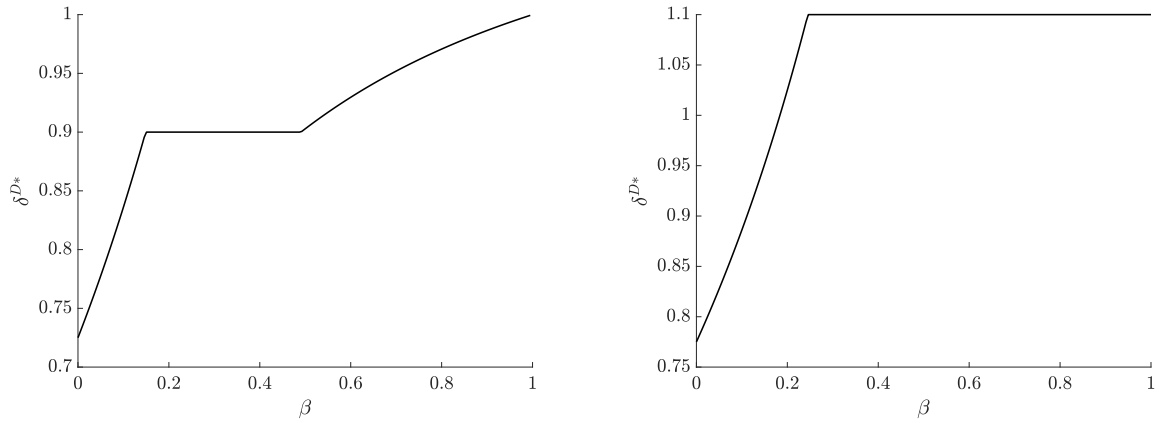
Panel (a) of Figure 1 illustrates the public policymaker's optimal decision on δ^D when $L = 0.45$. When β is low, the policymaker is concerned primarily with firm profits and chooses a moderate threshold δ^D. In the extreme case of $\beta = 0$, the policymaker chooses a threshold $\delta^D = 0.725$; then firms with low marginal returns to CSR $\alpha_i \in [0.45, 0.725)$ overinvest in CSR with an investment of $s_i^D = \delta^D > \alpha_i$ while firms with high marginal returns to CSR $\alpha_i \in (0.725, 1]$ underinvest in CSR with an investment of $s_i^D = \delta^D < \alpha_i$. While firms always distort their investment decisions, the magnitude of the distortion, $|\alpha_i - \delta^D|$, is relatively small, which guarantees sufficient profits.

In the other extreme case of $\beta = 1$, the policymaker is only concerned with CSR and thus selects a high $\delta^D = 1$. In this case, firms with very low marginal returns to CSR $\alpha_i \in [0.45, 0.5)$ underinvest in CSR with an investment of $s_i^D = 0 < \alpha_i$ while firms with moderate or high marginal returns to CSR $\alpha_i \in (0.5, 1)$ overinvest in CSR with an investment of $s_i^D = \delta^D > \alpha_i$.

Because the latter firms invest aggressively, the aggregate CSR investment amount is maximized regardless of underinvestment from other firms (i.e., firms with suboptimal CSR performance).

Furthermore, Proposition 2 demonstrates that, when L is small, the public policymaker may set a higher disclosure threshold (relative to L) compared to when L is large. When L is small, the inefficiency generated from firms overinvesting can become even higher; therefore, the policymaker chooses δ^D that is relatively high to preclude firms with low α_i from investing. This explains why δ^{D*} has three possible solutions when L is small, including one solution with a threshold that is higher than that of $2L$, which is not present when L is large.

Panel (b) of Figure 1 illustrates the optimal disclosure threshold for various values of β when L is set to a larger value, specifically $L = 0.55$. In comparison to Panel (a), the optimal threshold in Panel (b) is higher in absolute terms, which is intuitive since a higher L implies that the firm perceives, on average, higher benefits from investing in CSR, allowing the policymaker to set a higher threshold since firms that do not invest enough in CSR become less of a concern.



(a) $L = 0.45$ (b) $L = 0.55$

Figure 1: Optimal threshold under discrete disclosure

3.6 Discrete Disclosure vs. Full Disclosure

Our analysis shows that, compared to no disclosure, both full and discrete disclosure policies incentivize firms to invest in CSR, thereby benefiting firms and society as a whole. However, it remains unclear which of the two disclosure policies is more effective from the perspective of

public policy. We thus compare the policymaker's payoff under the two disclosure regimes and summarize our results in the following proposition:

Proposition 3 (Discrete disclosure vs. Full disclosure)**.** *When the public policymaker is concerned primarily with firm profits (i.e., when β is low enough), they prefer full disclosure over discrete disclosure. When they are concerned primarily with CSR (i.e., when β is high enough), they prefer discrete disclosure over full disclosure.*

Proposition 3 presents our paper's main finding: the public policymaker prefers discrete disclosure over full disclosure when they are sufficiently concerned about CSR. As outlined in Proposition 1, when the disclosure threshold is high but not too high, firms are incentivized to overinvest in CSR, which may reduce their financial returns but is still more profitable than not investing at all. As for public policymakers, overinvestments reduce firm profits but increase aggregate CSR, which is preferred when they prioritize CSR. In other words, the disclosure threshold provides policymakers with a tool that (partially) internalizes the externalities of CSR investments: while full disclosure allows firms to fine-tune capital market incentives and ignore the social benefits of their CSR investments, discrete disclosure, by distorting capital market incentives, results in firms distorting their investments and thus effectively internalizing the investment externalities.

Figure 2 illustrates the result of Proposition 3. It can be seen that, when β is low, the public policymaker's payoff is higher under full disclosure, which encourages firms to efficiently invest in CSR. When β is high, the public policymaker's payoff is higher under discrete disclosure, which encourages the majority of firms to overinvest in CSR. Such improvements can be substantial: for instance, when $L = 0.45$ and $\beta = 1$, the public policymaker's payoff is $\Pi^C = 0.725$ under full disclosure but $\Pi^D \approx 0.909$ under discrete disclosure, a striking 25.4% improvement. This result showcases the significant role that disclosure policies play in incentivizing CSR investment.

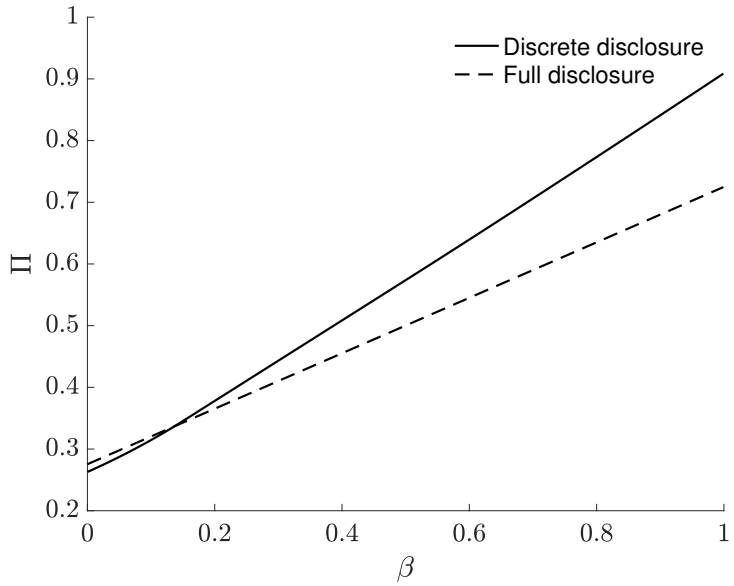


Figure 2: Discrete vs. Full Disclosure ($L = 0.45$)

4 Multiple Levels for Discrete Disclosure

In the basic model, we assume that there is a single level of disclosure under discrete disclosure, e.g., the firm either passes or fails the public policymaker's certification threshold. However, in practice, policymakers often adopt refined, multi-level disclosure policies. For instance, the European Union's energy label provides consumers with product information on energy efficiency, categorizing products into seven grades ranging from A to G.[14] Likewise, the MSCI ESG ratings assign firms into seven categories spanning from AAA to CCC.[15] The Ministry of Health of Singapore also implements Nutri-Grade labelling requirements for beverages sold in Singapore, grading beverages into four categories ranging from A to D.[16]

In this section, we consider the effect of having multiple levels of discrete disclosure. For the sake of tractability, we consider two levels of disclosure and assume that $L = 0$. Our results also hold for other $L < 1$. We use δ_1^M and δ_2^M to represent the two thresholds, where $\delta_1^M < \delta_2^M$. Superscript M stands for multiple disclosure.

[14] https://energy-efficient-products.ec.europa.eu/ecodesign-and-energy-label/understanding-energy-label_en
[15] https://www.msci.com/sustainable-investing/esg-ratings
[16] https://www.hpb.gov.sg/healthy-living/food-beverage/nutri-grade

Given the disclosure thresholds, the firms make their disclosure decisions. As discussed in the basic model, firms' equilibrium investment decisions must satisfy $s_i^M \in \{0, \delta_1^M, \delta_2^M\}$. Solving the firms' optimal disclosure decision, we arrive at the following lemma:

Lemma 4 (Investment under multiple disclosure)**.** *With multiple disclosure thresholds, the firms' optimal CSR investment decision is as follows:*

$$s_i^M = \begin{cases} 0 & \text{if } \alpha_i < \frac{\delta_1^M}{2}, \\ \delta_1^M & \text{if } \frac{\delta_1^M}{2} \leq \alpha_i \leq \frac{\delta_1^M + \delta_2^M}{2}, \\ \delta_2^M & \text{otherwise.} \end{cases} \tag{9}$$

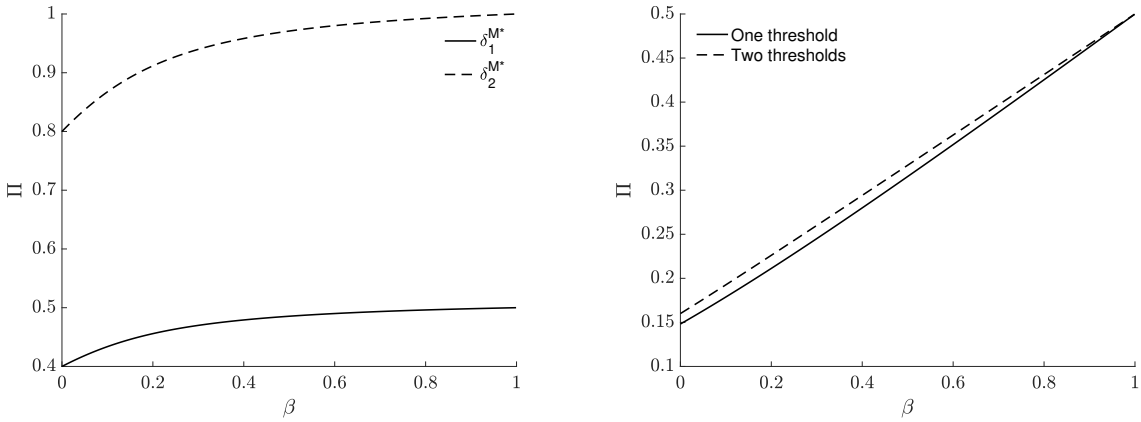
Lemma 4 suggest that firms with low marginal returns to CSR do not invest, firms with moderate marginal returns to CSR make a moderate investment by choosing $s_i^M = \delta_1^M$, and firms with high marginal returns to CSR make a high investment by choosing $s_i^M = \delta_2^M$. The intuition is similar to when disclosure is limited to a single level: The number of firms' investment levels equals the number of disclosure thresholds set, because stakeholders' beliefs (given each disclosure threshold) are fixed and there is no additional benefit to investing beyond those thresholds. Firms that stand to gain higher marginal benefits from investing in CSR incur either less costs associated with overinvesting or more costs associated with underinvesting; thus, they are willing to choose higher levels of investment.

Next, we investigate the public policymaker's optimal choice for the disclosure thresholds. We relegate the analysis to the appendix and present our results in the following proposition:

Proposition 4 (Optimal threshold under multiple disclosure)**.** *With multiple disclosure thresholds, the public policymaker's optimal thresholds are*

$$\delta_1^{M*} = \frac{2}{15}\left(\frac{4}{1-\beta} - \frac{\sqrt{1+15\beta^2}}{1-\beta}\right), \quad \delta_2^{M*} = \frac{4}{15}\left(\frac{4}{1-\beta} - \frac{\sqrt{1+15\beta^2}}{1-\beta}\right).$$

Panel (a) of Figure 3 illustrates how the policymaker's optimal thresholds change with β. Akin to the basic model, the policymaker prioritizes CSR as β increases. In response, they set higher



(a) Optimal thresholds

(b) The effect of multiple thresholds

Figure 3: Multiple disclosure ($L = 0$)

thresholds δ_1^M and δ_2^M, which encourage firms with moderate and high marginal returns to CSR to invest aggressively.

Panel (b) of Figure 3 shows the effect that multiple thresholds have on the public policymaker's payoff. It follows immediately that the policymaker is better off adopting two disclosure thresholds. That is, when there is only one disclosure threshold (discrete disclosure), firms with either low or high marginal returns to CSR can choose to underinvest; in fact, even if they prefer to invest (and thus benefit) more, they cannot credibly communicate such an investment to stakeholders due to the binary nature of the disclosure suppressing too much information. With two disclosure thresholds, however, firms can more manageably match one of the thresholds according to the marginal benefits they stand to gain from their CSR investments, which alleviates the issue of underinvestment. As a result, firm profits and the aggregate CSR investment increase, and so is the public policymaker's payoff.

5 Censored Disclosure

In the basic model, we showed that, when the public policymaker is sufficiently concerned with CSR (i.e., when β is high enough), they prefer discrete disclosure over full disclosure. Nonetheless, discrete disclosure also generates inefficiencies associated with underinvesting: that is, underin-

vesting reduces firm profitability as well as the aggregate amount invested into CSR, thereby hurting both the firm and social welfare. In this section, we consider an alternative type of disclosure, censored disclosure, which reduces the inefficiency caused by underinvestment and improves the public policymaker's payoff.

Mathematically, consider the following disclosure policy. Similar to discrete disclosure, the public policymaker chooses a threshold δ^C, where the superscript C stands for censored disclosure. If the firm's CSR investment falls below the threshold δ^C (i.e., $s_i^C < \delta^C$), nothing is disclosed (i.e., $s_i^C = \emptyset$). However, if the CSR investment is equal to or greater than the threshold δ^C, the firm is allowed to disclose the exact amount of the investment to stakeholders:

$$I_i^C = \begin{cases} \emptyset & \text{if } \ s_i < \delta^C, \\ s_i^C & \text{otherwise.} \end{cases} \tag{10}$$

In this sense, censored disclosure can be viewed as a hybrid between nondisclosure and full disclosure: nondisclosure is adopted when the CSR investment is low, and full disclosure is implemented when it is high.

Given the disclosure threshold, the firms' optimal investment decision is as follows.

$$s_i^C = \begin{cases} 0 & \text{if } \ \alpha_i < \frac{\delta^C}{2}, \\ \delta^C & \text{if } \ \frac{\delta^C}{2} \leq \alpha_i < \delta^C, \\ \alpha_i & \text{otherwise.} \end{cases} \tag{11}$$

The firm's investment strategy in Equation (11) has three segments: When the firm's marginal return to CSR is low enough (i.e., when $\alpha_i < \frac{\delta^C}{2}$), the firm does not invest at all since it cannot afford to invest at least $s_i^C = \delta^C$. When its marginal return to CSR is high but not too high (i.e., when $\frac{\delta^C}{2} \leq \alpha_i < \delta^C$), the firm invests exactly at the threshold level to ensure disclosure. If its marginal return to CSR is high enough (i.e., when $\alpha_i > \delta^C$), the firm invests beyond the threshold to benefit more from its investment.

Consider next the public policymaker's optimal decision on the disclosure threshold δ^C. Straight-

forward algebra yields that, when $L \leq 0.5$, the policymaker's payoff is

$$\Pi^C = \begin{cases} \frac{1+2\beta+L(1+L+2\beta-L\beta)}{6} & \text{if } \delta^C \leq L, \\ \frac{1-3L^2\delta^C+3L(\delta^C)^2-(\delta^C)^3+\beta(2+\delta^C(3L^2-3L(2+\delta^C)+\delta^C(3+\delta^C)))}{6(1-L)} & \text{if } L \leq \delta^C \leq 2L, \\ \frac{4-(\delta^C)^3+\beta(8+(\delta^C)^3)}{24(1-L)} & \text{if } 2L \leq \delta^C \leq 1, \\ \frac{\delta^C(2-\delta^C)(2+2\beta-\delta^C+\beta\delta^C)}{8(1-L)} & \text{if } 1 \leq \delta^C \leq 2, \\ 0 & \text{if } \delta^C > 2. \end{cases} \tag{12}$$

When $L \geq 0.5$, the policymaker's payoff is

$$\Pi^C = \begin{cases} \frac{1+2\beta+L(1+L+2\beta-L\beta)}{6} & \text{if } \delta^C \leq L, \\ \frac{1-3L^2\delta^C+3L(\delta^C)^2-(\delta^C)^3+\beta(2+\delta^C(3L^2-3L(2+\delta^C)+\delta^C(3+\delta^C)))}{6(1-L)} & \text{if } L \leq \delta^C \leq 1, \\ \frac{\delta^C(1+\beta+(1-\beta)(L-\delta^C))}{2} & \text{if } 1 < \delta^C < 2L, \\ \frac{\delta^C(2-\delta^C)(2+2\beta-\delta^C+\beta\delta^C)}{8(1-L)} & \text{if } 2L \leq \delta^C \leq 2, \\ 0 & \text{if } \delta^C > 2. \end{cases} \tag{13}$$

We then investigate the public policymaker's optimal decision on δ^C and obtain the following lemma:

Lemma 5 (Optimal threshold under censored disclosure)**.** *Under censored disclosure, when* $L \leq 0.5$*, the public policymaker's optimal disclosure threshold is*

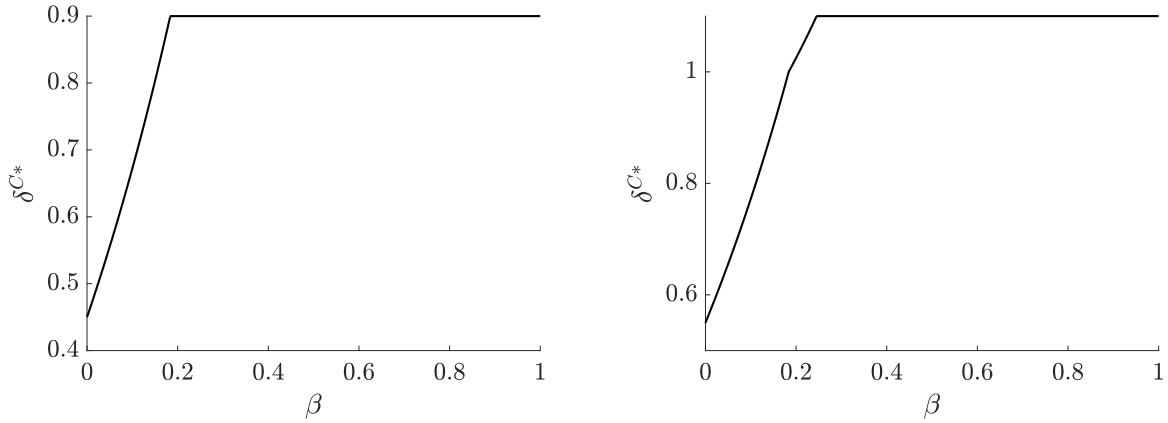
$$\delta^{C*} = \begin{cases} L + \frac{2\beta}{1-\beta} & \text{if } \beta < \frac{L}{2+L}, \\ 2L & \text{otherwise.} \end{cases} \tag{14}$$

When $L \geq 0.5$*, the public policymaker's optimal disclosure threshold is*

$$\delta^{C*} = \begin{cases} L + \frac{2\beta}{1-\beta} & \text{if } \beta < \frac{1-L}{3-L}, \\ \frac{1+L+\beta-L\beta}{2-2\beta} & \text{if } \frac{1-L}{3-L} \leq \beta \leq \frac{3L-1}{3L+1}, \\ 2L & \text{otherwise.} \end{cases} \tag{15}$$

The intuition for Lemma 5 is essentially the same as that of Proposition 2, with the key difference being that there are more possible solutions for optimal thresholds when L is large relative to when L is small. Intuitively, under censored disclosure, the policymaker cares only about inducing firms that have an incentive to underinvest to invest more; when L is large, the cost to induce underinvesting firms is smaller, and the policymaker can thus set a more refined threshold to encourage increased investments from these firms that would otherwise choose nondisclosure.

Moreover, Figure 4 plots the optimal disclosure threshold under censored disclosure. As in Proposition 2, the threshold increases in L and β, i.e., the policymaker sets a higher threshold to encourage more investment when firms are more willing to invest in CSR and when the policymaker prioritizes CSR, respectively.



(a) $L = 0.45$ (b) $L = 0.55$

Figure 4: Optimal threshold under censored disclosure

The following proposition summarizes the implications of censored disclosure for the policymaker.

Proposition 5 (Censored disclosure vs. full disclosure vs. discrete disclosure)**.** *In comparing censored disclosure with discrete and full disclosure, we observe the following:*

(1) The public policymaker always prefers censored disclosure over full disclosure;

(2) The public policymaker always prefers censored disclosure over discrete disclosure.

The policymaker's preference in Part (1) of Proposition 5 is intuitive: by establishing a zero disclosure threshold, censored disclosure can effectively replicate full disclosure. Consequently, the policymaker's payoff under censored disclosure is at least equal to that under full disclosure. In fact, the policymaker strictly prefers censored disclosure as long as there is a positive concern for CSR investments (i.e., $\beta > 0$). By setting a positive disclosure threshold, firms with low marginal returns on CSR are incentivized to overinvest, thereby enhancing the policymaker's overall payoff.

Part (2) of Proposition 5 states that the policymaker prefers censored disclosure also over discrete disclosure. With discrete disclosure, firms with high marginal returns to CSR underinvest. More specifically, consider a firm with $\alpha_i > \delta^D$: if the firm could disclose its CSR investment directly to stakeholders, it chooses an investment level of $s_i = \alpha_i > \delta^D$. However, when the firm can only disclose whether or not its investment is greater than the threshold, it has no incentive to invest over δ^D; in this case, the firm undercuts its investment level at $s_i^D = \delta^D$. Such an underinvestment hurts both firm profits and the aggregate CSR investment. Under censored disclosure, the firm can accurately communicate its investment level to stakeholders and no longer needs to distort its investment decision downward. Such an improvement boosts both firm profits and the aggregate CSR investment as the policymaker intended.

6 Empirical and Policy Implications

Our results have empirical and policy implications. First, we show that, while disclosing CSR investments is always better than not disclosing, discrete disclosure is preferred over full disclosure, in particular for public policymakers who emphasize and encourage the externalities of CSR investment. Our results not only justify the disclosure of CSR activities but also caution disclosures against becoming too granular, especially when some activities (e.g., investments into green technologies that reduce level 3 GHGs) cannot be perfectly measured. Discrete disclosure also supports regulatory use of discrete CSR ratings such as MSCI ESG ratings. As discussed before,

our investigation of discrete disclosure is different from continuous but noisy measurements of CSR investments, which result in severe underinvestment. This makes our discrete disclosure also related to vague or qualitative statements, if such vague or qualitative statements is informationally equivalent to conveying an interval that firms' CSR investments lie in.

Second, we demonstrate that, even if CSR investments can be measured precisely, censored disclosure reduces underinvestment from firms with high marginal private returns to CSR investments and thus improves upon both full and discrete disclosure, if the policymaker cares sufficiently about CSR. To the extent that the disclosure threshold corresponds to the materiality threshold, this result justifies disclosing CSR investments only if they surpass some materiality threshold, as discussed in, e.g., Khan et al. (2016) and Grewal et al. (2019).

Finally, our comparative statics results on disclosure thresholds provide empirical implications regarding how the materiality threshold should vary with exogenous parameters. For example, perhaps counterintuitively, the disclosure threshold increases — which results in fewer disclosures or a higher proportion of firms with suboptimal CSR performance — when policymakers care more about externalities and CSR than firm profits. In this case, policymakers increase the disclosure threshold to alleviate underinvestment, resulting in increased levels of investment in CSR specifically by firms that have higher private returns from CSR or, to the extent that α_i is also a proxy for CSR preference amongst stakeholders, by firms that have higher proportions of stakeholders who emphasize the importance of CSR. The overall CSR investment from these firms is higher than what is observed under full or discrete disclosure, even though it is associated with a higher proportion of firms that do not (or, more precisely, cannot) disclose (i.e., firms with suboptimal CSR performance that do not invest to the disclosure threshold).

7 Conclusion

Modern firms are increasingly investing in CSR activities to address their stakeholders' concerns with social justice and responsibility and to earn long-term benefits associated with improved

processes and reputation. When engaging in CSR projects, firms must disclose their investments to enjoy the benefits of upholding CSR, e.g., better brand image and consumer satisfaction. Different standards exist for disclosing CSR activities, with some making every detail transparent and others simply releasing a grade for a firm's CSR engagements.

In this paper, we built a game-theoretical model to understand the role that disclosure standards play in firms' CSR investments and their ensuing benefits to society as a whole. We consider three disclosure regimes. Under nondisclosure, firms cannot disclose anything to their stakeholders; under full disclosure, firms disclose all CSR engagements to their stakeholders; under discrete disclosure, firms only disclose whether their CSR investments passed a certain threshold. We further endogenized firms' CSR investment decisions to investigate how disclosure standards affect such decisions.

We found that the selected disclosure policy can significantly influence the incentives firms have to engage in CSR. More specifically, under discrete disclosure, a firm can only choose between making no CSR investments or investing to an established threshold; therefore, a firm can overinvest or underinvest in CSR under this policy. Taking this into consideration, public policymakers can intentionally choose a threshold that induces the desired level of CSR investment made by firms. If the policymaker is primarily concerned with CSR over firm profits, a discrete disclosure policy is optimal compared to no or full disclosure since it garners more CSR investments on average. Collectively, these results suggest the non-trivial role that disclosure standards play and recommend that regulators account for firms' strategic responses when designing public policies.

A Appendix: Proofs

Proof of Lemmas 1 and 2. See the main text.

Proof of Lemma 3. Assume for the sake of contradiction that firm i's investment intensity is $s_i^D \notin \{0, \delta^D\}$. There are two cases to consider: (1) $0 < s_i^D < \delta^D$ and (2) $s_i^D \geq \delta^D$. In the former case, the firm's investment falls short of the threshold and, therefore, stakeholders hold the belief that the firm's investment intensity is $\hat{s}_L^D$. In this sense, firm i's profit is given by $\pi_i^D = \alpha_i \hat{s}_L^D - (s_i^D)^2/2$. Clearly, the firm can do better off by making an investment of $s_i^D = 0$. By doing so, the firm's payoff will be $\alpha_i^D \hat{s}_L^D > \alpha_i \hat{s}_L^D - (s_i^D)^2/2$, higher than before. In the latter case, the firm's investment is above the threshold and, therefore, stakeholders believe the firm's investment to be $\hat{s}_H^D$. As such, firm i's profit is $\pi_i^D = \alpha_i \hat{s}_H^D - (s_i^D)^2/2$. Clearly, the firm can do better off by making an investment of $s_i^D = \delta^D$ instead, under which its profit will be $\alpha_i \hat{s}_H^D - (\delta^D)^2/2 > \alpha_i \hat{s}_H^D - (s_i^D)^2/2$, higher than before. This completes the proof. Q.E.D.

Proof of Proposition 1. By comparing the firm's investment under the discrete disclosure s_i^D as given by (3) with that under the full disclosure as given by $s_i^F = \alpha_i$, we find that $s_i^D > s_i^F$ when $\frac{\delta^D}{2} \leq \alpha_i < \delta^D$, which is equivalent to the condition $\alpha_i < \delta^D \leq 2\alpha_i$. Q.E.D.

Proof of Proposition 2. The optimal threshold δ^D is given by (5) and (6), depending on δ^D relative to L and β. Note that both L and β lie within $(0, 1)$. Denote the two thresholds of β as $\bar{\beta}_1 \equiv \frac{3L-1}{3L+1}$ and $\bar{\beta}_2 \equiv \frac{3L^2-4L+1}{3L^2-1}$. We have the following findings: (i) When $L < 1/3$, both $\bar{\beta}_1 < 0$ and $\bar{\beta}_2 < 0$. Thus, $\delta^{D*} = \frac{4-2\sqrt{1+3\beta^2}}{3(1-\beta)}$. (ii) When $1/3 < L < 1/2$, $0 < \bar{\beta}_1 < \bar{\beta}_2 < 1$. Thus, if $\beta < \bar{\beta}_1$, $\delta^{D*} = \frac{1+\beta+L(1-\beta)}{2(1-\beta)}$, if $\bar{\beta}_1 < \beta < \bar{\beta}_2$, $\delta^{D*} = 2L$, and otherwise, $\delta^{D*} = \frac{4-2\sqrt{1+3\beta^2}}{3(1-\beta)}$. (iii) When $L > 1/2$, in equation (6) we always have $\delta^D = 2L$ for the moderate threshold. Thus, the optimal threshold is determined by equation (5). The proposition summarizes these results. Q.E.D.

Proof of Proposition 3. Consider first the extreme case of $\beta = 0$. In this case, the public policymaker simply maximizes the firms' total payoff. Firm i's payoff under full disclosure is $\pi_i^F = \alpha_i^2/2$, where its payoff under discrete disclosure is $\pi_i^D = \max\left(\alpha_i \delta^D - (\delta^D)^2/2, 0\right)$. It can be verified that for any δ^D, we have $\pi_i^F \geq \pi_i^D$, i.e., firm i is better off with full disclosure regime. Since each firm is better off with full disclosure, the aggregate firm profit is also higher under this regime.

In the other extreme case of $\beta = 1$, the public policymaker simply maximizes the aggregate CSR. Under full disclosure, the aggregate CSR is $\Delta^F = \frac{1+L}{2}$. Under discrete CSR, by choosing $\delta^D = 1$, the public policymaker can achieve an aggregate CSR at:

$$\Delta^D = \begin{cases} \frac{1}{2(1-L)} & \text{if } L \leq \frac{1}{2}, \\ 1 & \text{otherwise,} \end{cases} \tag{16}$$

which is always greater than $\Delta^F = \frac{1+L}{2}$. Note that the aggregate CSR in Equation (16) is just a lower bound for aggregate CSR as the public policymaker can potentially do better by charging a different δ^D. Therefore, the public policymaker must be better off with discrete disclosure.

Finally, because both Π^D and Π^F are continuous, we prove that the public policymaker prefers full disclosure when β is low enough but discrete disclosure when β is high enough. Q.E.D.

Proof of Lemma 4. If firm i chooses $s_i^M = 0$, its profit will be $\pi_{i0}^M = 0$. If firm i chooses $s_i^M = \delta_1^M$, its profit will be $\pi_{i1}^M = \alpha_i \delta_1^M - (\delta_1^M)^2/2$. If firm i chooses $s_i^M = \delta_2^M$, its profit will be $\pi_{i2}^M = \alpha_i \delta_2^M - (\delta_2^M)^2/2$. Comparing firm profits under the above three strategies, we prove the lemma. Q.E.D.

Proof of Proposition 4. Assume that $0 \leq \delta_1^M \leq \delta_2^M \leq 1$ (we verify later that this is indeed the case). Then, we can write the aggregate social welfare and firm profit as follows:

$$\Delta^M = \int_{\delta_1^M/2}^{(\delta_1^M+\delta_2^M)/2} \delta_1^M d\alpha_i + \int_{(\delta_1^M+\delta_2^M)/2}^{1} \delta_2^M d\alpha_i = \frac{(2-\delta_2^M)\delta_2^M}{2},$$

$$\pi^M = \int_{\delta_1^M/2}^{(\delta_1^M+\delta_2^M)/2} \alpha_i \delta_1^M - \frac{(\delta_1^M)^2}{2} d\alpha_i + \int_{(\delta_1^M+\delta_2^M)/2}^{1} \alpha_i \delta_2^M - \frac{(\delta_2^M)^2}{2} d\alpha_i = \frac{\delta_2^M((2-\delta_2^M)^2 - (\delta_1^M)^2 + \delta_1^M \delta_2^M)}{8}.$$

The public policymaker's payoff, $\Pi^M = \beta \Delta^M + (1-\beta)\pi^M$, can be written as

$$\pi^M = \frac{\delta_2^M(4 - 4\delta_2^M - ((\delta_1^M)^2 - \delta_1^M \delta_2^M - (\delta_2^M)^2)(1-\beta) + 4\beta)}{8}.$$

Maximizing the public policymaker's payoff, we prove the proposition. Q.E.D.

Proof of Lemma 5. Define the following regions based on the relationships between L and δ:

- Region 1 where $L < 1 < \delta/2$, equivalent to $\delta > 2$;

- Region 2 where $L < \delta/2 < 1 < \delta$, equivalent to $\max(2L, 1) < \delta < 2$;
- Region 3 where $L < \delta/2 < \delta < 1$, equivalent to $2L < \delta < 1$;
- Region 4 where $\delta/2 < L < 1 < \delta$, equivalent to $1 < \delta < 2L$;
- Region 5 where $\delta/2 < L < \delta < 1$, equivalent to $L < \delta < \min(1, 2L)$;
- Region 6 where $\delta/2 < \delta < L < 1$, equivalent to $\delta < L$.

The corresponding payoff for the policymaker in Region i is denoted as Π^{Ci}.

Consider the case when $L < 0.5$. The policymaker's payoff is given by equation (12); noting that Region 4 is empty. Examining the policymaker's payoff we find: (i) Π^{C2} is monotonically decreasing in δ in Region 2; (ii) Π^{C3} is monotonically decreasing in δ in Region 3; (iii) Π^{C5} is monotonically increasing when $L < \delta < L + \frac{2\beta}{1-\beta}$ and decreasing when $\delta > L + \frac{2\beta}{1-\beta}$; and (iv) Π^{C6} is independent of δ. Thus, the optimal threshold depends on the relative relationship between $2L$ and $L + \frac{2\beta}{1-\beta}$, as stated in the lemma.

Consider the case when $L > 0.5$. The policymaker's payoff is given by equation (13); noting that Region 3 is empty. Similar to the case when $L < 0.5$, the optimal threshold cannot be obtained in Regions 1, 2, or 6. Examining the policymaker's payoff we find: (i) Π^{C5} is monotonically increasing when $L < \delta < L + \frac{2\beta}{1-\beta}$ and decreasing when $\delta > L + \frac{2\beta}{1-\beta}$; (ii) Π^{C4} is increasing when $L < \frac{1+\beta+L(1-\beta)}{2(1-\beta)}$ and decreasing otherwise. Therefore, we have the following results: (1) If $\beta > \frac{3L-1}{3L+1}$, Π^C is increasing in Regions 4 and 5 and thus $\delta^{C*} = 2L$. (2) If $\frac{1-L}{3-L} < \beta < \frac{3L-1}{3L+1}$, Π^C is increasing in Region 5 and peaks at $\delta^{C^*} = \frac{1+\beta+L(1-\beta)}{2(1-\beta)}$ in Region 4. (3) If $\beta < \frac{1-L}{3-L}$, Π^C peaks at $\delta^{C^*} = \frac{1+\beta+L(1-\beta)}{2(1-\beta)}$ in Region 5 and decreasing in Region 4. Q.E.D.

Proof of Proposition 5. Proof of Part (1) of Proposition 5. As shown by the policymaker's payoff functions (12) and (13), setting a low threshold (i.e., $\delta^C \leq L$) allows the policymaker to achieve a payoff equivalent to that under full disclosure, i.e., $\Pi^C = \Pi^F$. Furthermore, the result $\lim_{\delta^C \to +L} \frac{\partial \Pi^C}{\partial \delta^C} > 0$ implies that the policymaker benefits from establishing a threshold higher than L.

Proof of Part (2) of Proposition 5. Let δ^{D*} be the optimal threshold under discrete disclosure. Then, the firms' equilibrium CSR investment decision will be

$$s_i^{D*} = \begin{cases} 0 & \text{if } \alpha_i < \frac{\delta^{D*}}{2}, \\ \delta^{D*} & \text{otherwise.} \end{cases} \tag{17}$$

Now, under censored disclosure, suppose that the public policymaker chooses a threshold $\delta^C = \delta^{D*}$. In this case, the firms' equilibrium CSR investment decision will be

$$s_i^C = \begin{cases} 0 & \text{if } \alpha_i < \frac{\delta^{D*}}{2}, \\ \delta^{D*} & \text{if } \frac{\delta^{D*}}{2} \leq \alpha_i < \delta^{D*}, \\ \alpha_i & \text{otherwise.} \end{cases} \tag{18}$$

Comparing Equations (17) and (18), the firms' investment decision differs only when $\delta^{D*} \leq \alpha_i \leq 1$. Within this regime, firm i's CSR investment satisfies that $s_i^C = \alpha_i > s_i^{D*} = \delta^{D*}$, and the firm's profit satisfies that

$$\pi_i^C = \frac{\alpha_i^2}{2} > \alpha_i \delta^{D*} - \frac{(\delta^{D*})^2}{2} = \pi_i^{D*}.$$

That is, both the firm's profit and the CSR investment are higher under the censored disclosure regime than under the full disclosure regime. In this case, the public policymaker must also be better off with censored disclosure. Note that when the public policymaker can freely choose its δ^D, she can only be weakly better off with censored disclosure. This completes the proof. Q.E.D.

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