Disclosure Standards for Corporate Social Responsibility

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08/20/25

Abstract

Modern firms are increasingly investing in corporate social responsibility (CSR) activities and disclosing their CSR investments to stakeholders. Various disclosure standards exist for such CSR disclosure. Most notably, in addition to allowing firms to fully disclose their CSR engagements, some disclosure standards adopt a simple disclosure policy by assigning firms' CSR engagements into several discrete categories (e.g., A to D). Such arrangements seem to reduce the information content of disclosure, making disclosure less meaningful. In this paper, we develop an analytical model of CSR disclosure to understand firms' CSR investments under different disclosure standards. Our analysis shows that when firms' CSR engagements are endogenously determined, discrete disclosure incentivizes certain firms to overinvest in CSR activities, thereby benefiting the whole society. This research guides public policy makers in designing their CSR disclosure standards, determining materiality thresholds for CSR, and helps firms make optimal investments in CSR activities.

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

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1 Introduction

Corporate Social Responsibility (CSR) is becoming increasingly prevalent across various industries and regions. Firm often have objectives beyond profit maximization and engage in activities that enhance other stakeholders' welfare, such as investing in environmental friendly production process, selecting responsible suppliers, offering employee benefits, and helping disadvantaged groups (Liang and Renneboog, 2017). Every year, Fortune 500 companies spend approximately $20 billion in their CSR activities (Iglesias, 2022).

CSR has also attracted significant attention from the government, employees, suppliers, investors, consumers, and other stakeholders. Stobierski (2015) revealed that 70% of Americans believe it's somewhat or very important for firms to make the world a better place. Hughes (2017) noted that consumers support brands that contribute to the greater societal good, which incentivizes firms to engage in CSR. Bauman and Skitka (2012) suggested that corporate social responsibility increases organizational pride, employee satisfaction and in-role performance. Realizing the benefit of CSR, various government regulations and initiatives have been proposed to encourage CSR. For instance, India's Companies Act 2013 mandates large companies to spend at least 2% of their average net profits on CSR activities. More regulatory bodies take a milder approach to regulate CSR: while they do not mandate firms to engage in CSR activities, they do require or, at the very least, encourage firms to disclose and report their CSR activities. European Union's Non-Financial Reporting Directive, for example, requires large public-interest companies with more than 500 employees to disclose information on environmental, social, and governance (ESG) matters in their annual reports. The United Kingdom's Companies Act 2006 requires firms to report on the impact of the their business on the environmental, social, community, and human rights issues. It is thus unsurprising to see firms increasingly disclose and report their CSR activities: KPMG (2024) surveyed the world's top 250 companies, finding that 96% of them reported on sustainability and 95% of them published a carbon target. The Governance & Accountability Institute found that nearly all S&P500 reported their CSR activities with 98.6% publishing a report

in 2023.[1]

CSR disclosure varies in their formats. Common disclosure standards such as the Global Reporting Initiative (GRI) and Sustainable Accounting Standards Board (SASB) offer frameworks for firms to report their CSR activities through standardized guidelines, and firms can report their detailed CSR activities following these standards. Meanwhile, governments and third-party organizations often adopt a simpler approach to measure and disclose firms' CSR performances: Instead of providing detailed information on firms' CSR engagement, they simply classify firms into a few categories or ratings based on their CSR activities.

At first glance, it seems that the quality of CSR disclosure is high when it contains quantitative information about firms' CSR engagements instead of just qualitative information or coarse information like categories or ratings (Bowman and Haire, 1976; Shane and Spicer, 1983). High-quality CSR disclosure, on the other hand, brings benefits such as increased liquidity, lower cost of capital, access to public debt markets, and better investor perceptions and intentions (Stuart et al., 2022). This naturally raises the question of why governments and third-party organizations adopt the simple discrete disclosure policy.

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

[1] https://www.ga-institute.com/storage/press-releases/article/ga-institutes-research-shows-2023-sustainability-reporting-at-recor

[2] An alternative interpretation is that firms have heterogenous investor CSR preferences that value firms' CSR investments differently.

on CSR and firm profits.

Our model yields a few noteworthy findings. First, we find that while firms do not make any investment in CSR under the nondisclosure regime, they invest efficiently under the full disclosure regime. This is because when investment is unobservable, investors form a conjecture about firms' investment. Since such conjecture is fixed, firms enjoy no benefit from costly CSR investment and thus will rationally choose not to make any. Interestingly, under the discrete disclosure regime, the firms' disclosure decision is binary: They either make an investment at exactly the threshold level, or do not make an investment at all. The reason is that if investment does not cross the threshold, investors still value the firm based on their conjecture, resulting in no investment. Once the firm invests at the threshold level, investors will correctly conjecture that the firm invests at the threshold level and there is no benefit from further investing. We further find that both underinvestment and overinvestment can take place under discrete disclosure, which depends on the firms' marginal return to CSR investment. The intuition is as follows. As the firms' investment strategy is binary, when firms' marginal return to disclosure is not too high, they either distort their investment level downward to zero, or distort their investment level upward to the disclosure threshold to make disclosure happen. When the firms' marginal return to CSR is low, they prefer downward distortion and, therefore, underinvest in CSR; when the firms' marginal return to CSR is high (but not too high), they prefer upward distortion and, therefore, overinvest in CSR.

Second, we find that disclosure standards have significant impact on the public policy maker's payoff. When the public policy maker is primarily concerned with firm profits, she always prefers full disclosure to discrete disclosure; however, when the public policy maker is primarily concerned with CSR, she always prefers discrete disclosure to full disclosure. This is because, by strategically choosing a disclosure threshold, the public policy maker can induce more firms to overinvest in CSR, thereby generating higher aggregate CSR investment. Even though the firms are worse off from making suboptimal investment decision, the public policy maker is overall better off due to more CSR investments. This result cautions public policy makers that more

detailed disclosure policies are not always better, and they should set disclosure standards strategically to induce their desired outcomes. This result also provides justification for the regulators' reliance on discrete CSR/ESG ratings provided by, e.g., MSCI, in particular if the regulators are very concerned about firms underinvesting in CSR activities as they do not account for positive externalities generated by those activities.

Last, we consider two extensions of discrete disclosure: multiple levels of discrete disclosure and censored disclosure. Under multiple levels of discrete disclosure, the public policy maker sets a few categories of CSR investment and discloses which category a firm belongs to. Under censored disclosure, the public policy maker again chooses a disclosure threshold below which nothing will be disclosed. When the firm's investment exceeds the threshold, however, the public policy maker discloses the exact amount of the firm's 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 policy maker's payoff. The censored disclosure policy provides justification for the materiality threshold emphasized by CSR/ESG disclosure standard setters: disclose such activities only when the amount of investment is significant (i.e., material enough).

The rest of the paper is organized as follows. After reviewing related literature, Section 2 introduces the model and Section 3 solves the model. Sections 4 and 5 study two extensions of discrete disclosure: multiple levels of discrete disclosure and censored disclosure. Section 6 discusses model implications. Finally, Section 7 concludes.

1.1 Related Literature

Our paper is related to several streams of literature. First, it is related to a growing literature on the economic consequences of CSR/ESG disclosures.[3] In this stream of literature, our paper is most closely related to the real effects of CSR/ESG disclosure. For example, Mahieux et al. (2025) study how mandating greenhouse gas emissions disclosure may result in emissions leakage, Xue (2023) shows how measuring the outcome of ESG investment can discipline firms' investments that have

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

both a cash flow and an ESG impact, and Friedman et al. (2024) study the interaction between ESG reports and financial reports in disciplining managers' unobservable investment/effort decisions. We focus on how the discrepancy between a policy maker and firm due to, e.g., firms' failure to account for positive externalities of their CSR investment, may induce the policy maker to use different mandatory disclosure regulations to affect firms' CSR investments. Different from Friedman et al. (2024), we only focus on CSR disclosure; different from Mahieux et al. (2025) and Xue (2023), we focus on measurement of unobservable CSR investments rather than the outcome of CSR investments, which makes the issue of measurement precision moot, as it is well-known from the real effects literature that noisy measure of any endogenous decisions have no information content (e.g., Matthews and Mirman, 1983; Kanodia et al., 2005). We nevertheless show that imperfect disclosure in the form of discrete or censured disclosure can be optimal from a social welfare maximizing perspective, which generates very different implications from the literature focusing on measurement of ex-post CSR outcomes.

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

Finally, the disclosure strategy of suppressing information through discrete intervals is related to the well-known optimal disclosure results 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 requires firms' commitment. While in cheap talk models information is suppressed to avoid the receiver taking advantage of the sender's message, in our setting information is suppressed to change the sender's real decisions that benefits the receiver.

2 The Model

Firms. There is a continuum of firms of unit measure (i.e., on $[0, 1]$), and each firm makes an investment in CSR. For instance, a power plant can invest in new technologies to reduce its carbon emissions, a high-tech company can offer technology access to underserved communities, and an agricultural goods manufacturing firm can improve the livelihoods of small farmers suppliers. We use $s_i \geq 0$ to denote firm i's CSR investment, with a higher s_i denoting more CSR investment activities. A firm's investment in CSR is not directly observed by other stakeholders in the market. For instance, it is in general difficult for the public to assess whether and 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, a firm can indirectly benefit from its CSR investments through a reputation effect because CSR activities, in general, improve a company's reputation among customers, employees, investors, and other stakeholders. 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.[4] Becker-Olsen et al. (2006) find that consumers reward firms for their CSR initiatives even if these initiatives are profit-motivated. Khan et al. (2016) empirically show that firms with good sustainability ratings significantly outperform firms with poor ratings.

To capture the above 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 CSR investment and $\hat{s}_i$

[4]CSR may bring other monetary benefits to the company, e.g., reduce energy consumption. While we abstract away from these effects, our main results will continue to hold in the presences of these effects.

is the other stakeholders' belief of the firm's CSR intensity, which will be specified later. In practice, firms are often heterogeneous in how much they benefit from CSR, with some firms benefiting more and others benefiting less from CSR. For instance, Isaksson and Woodside (2016) suggest that firms with good management benefit more from CSR activities whereas firms with bad management benefit less from them. In line with this observation, we assume that the marginal return to CSR, α_i, is privately observed by the firm. Investors perceive α_i to be uniformly distributed between L and H, where $H > L \geq 0$, i.e., $\alpha_i \sim U[L, H]$. In the remainder of the paper, we normalize $H = 1$ without loss of generality. Meanwhile, a firm also incurs a cost when investing in CSR, and we assume its cost is $s_i^2/2$. As mentioned by Wang and Bansal (2012), the more resources a firm allocates to CSR activities, the fewer resources the firm has available to improve its core business. Such a quadratic function captures decreasing marginal return to CSR investment. For instance, for a power plant, it is increasingly costly 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 here we abstract away from all other payoffs of the firm, which are not the focus of the present paper.

Public policy maker . The model consists of a public policy maker who is concerned with CSR. More specifically, the public policy maker benefits from a higher CSR level as CSR typically exerts positive externalizes to other stakeholders. For instance, CSR efforts that aim to reduce pollution, improve workplace safety, and enhance product quality to benefit the well-being of citizens, which is in line with the policy maker's objective.

In addition to caring about CSR investments, the public policy maker also cares about the firms' payoff for the following reasons. First, when the firms' profit increases, the government will be able to collect more tax from them. Second, a higher payoff from CSR investments will make CSR activities more sustainable and yield a long-term benefit to the society. Last, higher

firm profit is typically associated with higher salaries and consumption and lower unemployment rates, which benefits the whole society.

Following the discussion above, we adopt the following specification to model the policy maker's objective:

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

where $0 \leq \beta \leq 1$ is the weight placed on CSR whereas $1-\beta$ is the weight placed on firm profit. In the above 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. This specification implies that a public policy maker is concerned with both CSR and firm profit, and strikes a balance between the two. In the extreme case of $\beta = 0$, the public policy maker is concerned only about firm profit. In the other extreme of $\beta = 1$, the public policy maker is concerned only about CSR.

Disclosure. As discussed above, a firm's CSR investment is not directly observed by other stakeholders unless such information is certified and disclosed. Meanwhile, the public policy maker can design disclosure standards to sway the firms' CSR investment. In line with the business practice, we consider the following three disclosure regimes: Nondisclosure (N), full disclosure (F) and discrete disclosure (D, or category disclosure). We will also discuss other potential disclosure policies in an extension. Let I_i be the information disclosed by firm i.

- **Nondisclosure**: Under nondisclosure, a firm's CSR investment is always withheld, i.e., $I_i^N = \emptyset$ 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.

  It is worth mentioning that there are no regulations preventing firms from voluntarily disclosing their CSR activities and, therefore, firms can always disclose such information to the public. However, in the absence of certification and verification, such disclosure becomes cheap talk and does not carry any information, which is equivalent to the nondisclosure case.

- **Full Disclosure**: Under full disclosure, firm i truthfully discloses its CSR investment, i.e., $I_i^F = s_i$ for all firms.[5] In this scenario, there is no information asymmetry between the firm and its stakeholders. For instance, the Sustainability Accounting Standards Board (SASB) Standards allow firms to voluntarily disclose their sustainability information. Under such voluntary disclosure, firms will always truthful disclose their entire CSR activities, thereby facilitating full disclosure. EcoVadis, a rating agency, assigns an EcoVadis score (0-100) which reflects the quality of a firm's sustainability management and is largely in line with full disclosure.[6] We use superscript F to denote full disclosure.

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

$$I_i^D = \begin{cases} \emptyset & \text{if } \ s_i < \delta^D, \\ \text{High} & \text{if } \ s_i \geq \delta^D. \end{cases} \tag{1}$$

  The policy maker can decide on the threshold δ under discrete disclosure to maximize its objective, which will be discussed later.

  Discrete disclosure policies are widely adopted. For instance, B Lab Global, a nonprofit organization, offers B Corporation Certification to firms that meet a minimum score on the B Impact Assessment, which evaluates social and environmental performance.[7] Fairtrade International, a nonprofit aiming at promoting the lives of farmers and workers through fair trade, certifies products that have been produced according to fair trade political standards.[8]

[5] A firm can also choose to not disclose, however, according to the unraveling principle, nondisclosure will be treated as no CSR investment and is dominated by disclosure.

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

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

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

It is worth mentioning that in practice, public policy makers often adopt multiple discrete levels of disclosure, i.e., firms' CSR investments are good, satisfactory, or non-satisfactory (e.g., the red / yellow / green "traffic-light" system on the eToro platform).[9] We discuss this issue 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 the information available and form expectations about firm i's CSR investments. In this sense, we can rewrite the firm's payoff as follows:

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

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

Sequence of Moves. The game unfolds in three stages. In the first stage, the policy maker chooses its disclosure regime among nondisclosure, full disclosure and discrete disclosure. If it chooses discrete disclosure, it also chooses the disclosure threshold, δ^D, which is publicly observable to the market. In the second stage, each firm makes its CSR investment decision, and discloses according to the disclosure policy chosen by the policy maker in the first stage. In the third stage, based on the disclosed information, stakeholders make inference about each firm's CSR investment and firm profits are realized.

3 Model Analysis

In this section, we analyze the equilibrium outcome under different disclosure regimes. Then, we compare the equilibrium outcomes to derive the policy maker's optimal disclosure policy.

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

3.1 Nondisclosure Regime

Consider first the nondisclosure regime. Under this regime, none of the firms disclose and, as a result, all firms are indistinguishable to stakeholders who hold the same belief about the firms' CSR investment. Let $\hat{s}^N$ be stakeholders' common belief regarding firm i's CSR investment, which is a constant. Firm i thus chooses its CSR investment s_i^N to maximize its payoff

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

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

Lemma 1 (Nondisclosure)**.** *Under the nondisclosure regime, all firms choose not to invest in CSR, i.e.,* $s_i^N = 0$*. In equilibrium, all firms make zero profits and the policy maker's payoff is* $\Pi^N = 0$*.*

The intuition for Lemma 1 is as follows. Because the firms cannot disclose any information to stakeholders, stakeholders will always hold the same belief regardless of the firms' actual CSR investment. In other words, investing in CSR does not change stakeholders' belief. In recognition of this, the firms have no incentive to make any investment as all. In equilibrium, stakeholders also hold the rational belief that firms will not make any investments. 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 Regime

Consider next the full disclosure regime. Under this regime, all firms truthfully disclose their CSR investment s_i^F and, therefore, there is no information asymmetry between firms 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 the firm's profit is maximized at $\alpha_i^2/2$ by choosing $s_i^F = \alpha_i$. Given the firms' optimal strategy, the aggregate CSR investment and aggregate firm profit are respectively (note that 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 policy maker's payoff is $\Pi^F = \frac{\beta(1+L)}{2} + \frac{(1-\beta)(1+L+L^2)}{6}$.*

Lemma 2 shows that, compared with nondisclosure, full disclosure restores some market efficiency, leading to both higher firm profit and CSR investment. In this sense, the public policy maker strictly prefers full disclosure to nondisclosure.

3.3 Discrete Disclosure Regime

Consider now the discrete disclosure regime. Under this regime, the public policy maker chooses a disclosure threshold δ^D and discloses and certifies whether a firm's CSR investment passes the threshold. Because there are only two disclosure 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 about firm i's CSR investment when the disclosure threshold is met and not, respectively, which must be consistent with the firm's equilibrium investment decision. It is obvious that $\hat{s}_H^D \geq \delta^D > \hat{s}_L^D$.

Taking disclosure threshold 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' belief must be consistent with the firms' equilibrium investment decision, we have $\hat{s}_L^D = 0$ and $\hat{s}_H^D = \delta^D$. Firm i compares between the two investment choices (i.e., $s_i^D \in \{0, \delta^D\}$) to maximize its payoff. Comparing the two strategies, we find that firm i's investment decision also follows a threshold strategy:

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

The Effect of Discrete Disclosure on Firms' CSR Investment

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

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

Proposition 1 uncovers a key finding that, compared with full disclosure, a firm can invest more in CSR under the discrete disclosure. The intuition is as follows. Under full disclosure, regardless of its CSR investment, 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) Do not invest in CSR at all, i.e., $s_i^D = 0$, or (2) make a high investment in CSR, i.e., $s_i^D = \delta^D$. When $\frac{\delta^D}{2} \leq s_i^F = \alpha_i < \delta^D$, the firm either distorts its investment level downward to $s_i^D = 0$, or distorts its investment level upward to $s_i^D = \delta^D$. The former distortion is more severe than the latter and, therefore, the firm invests more under the discrete disclosure regime.

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 $s_i^D = 0$, leading to a payoff of $\pi_i^D = 0$, or increases its investment to $s_i^D = \delta^D = 0.8$, leading to a payoff of $\pi_i^D = 0.08$.

Comparing the above two strategies, the firm chooses to invest more.

Proposition 1 implies that public policy makers can strategically use disclosure policy as a tool to sway firms' investment decision. As the policy maker is concerned about the positive externalities brought by CSR investment, it can use the discrete disclosure policy to incentivize (some) firms to invest more in CSR.

Following the discussion above, we can immediately derive the policy maker's payoff as follows.

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

In Equation 3, when $\delta^D < 2L$, the threshold for disclosure is relatively too low, and all firms make a high CSR investment, i.e., $s_i^D = \delta^D$ to enjoy the benefit of CSR; when $\delta^D > 2$, the threshold for disclosure is relatively too high, and no firm can afford making such a high investment in CSR. As a result, 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 in CSR, while firms with higher marginal returns to CSR (i.e., $\alpha_i > \frac{\delta^D}{2}$) choose to invest in CSR and enjoy the ensuing benefit.

Public policy maker's Optimal Decision on δ^D

In the analysis above, we have discussed the equilibrium outcome given the disclosure threshold δ^D. Now, we move backward to investigate the public policy maker's optimal decision of δ^D. Following Equation 3, the public policy maker chooses between the following options:

- Choose a low threshold $\delta^D < 2L$: In this case, the public policy maker's payoff is $\Pi^D = \frac{\delta^D(1+\beta+(1-\beta)(L-\delta^D))}{2}$. Solving the public policy maker's maximization problem, we find that

her payoff is maximized at

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

- Choose a moderate threshold $2L \leq \delta^D \leq 2$: In this case, the public policy maker's payoff is $\Pi^D = \frac{\delta^D(2-\delta^D)(2+2\beta-\delta^D+\beta\delta^D)}{8(1-L)}$. Solving the public policy maker's maximization problem, we find that her payoff is maximized at

$$\delta^D = \max\left(2L, \frac{4-2\sqrt{1+3\beta^2}}{3(1-\beta)}\right). \tag{5}$$

- Choose a high threshold $\delta^D \geq 2$: In this case, the public policy maker's payoff is always 0.

Comparing the public policy maker's payoff under different scenarios, we arrive at the following proposition.

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

$$\delta^{D*} = \begin{cases} \frac{1+\beta+L-L\beta}{2(1-\beta)} & \text{if } \beta \leq \frac{3L-1}{1+3L}, \\ 2L & \text{if } \frac{3L-1}{1+3L} < \beta < \frac{1-4L+3L^2}{3L^2-1}, \\ \frac{4-2\sqrt{1+3\beta^2}}{3(1-\beta)} & \text{otherwise.} \end{cases} \tag{6}$$

When $L \geq 0.5$, we have

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

Proposition 2 characterizes the optimal threshold given L and β. It shows that for a given L, the optimal disclosure threshold increases with β. This result is intuitive. As β increases, the policy maker cares more about firm's CSR investments and thus is more willing to tolerate overinvestment of CSR. Correspondingly, the policy maker will set δ^D to be higher.

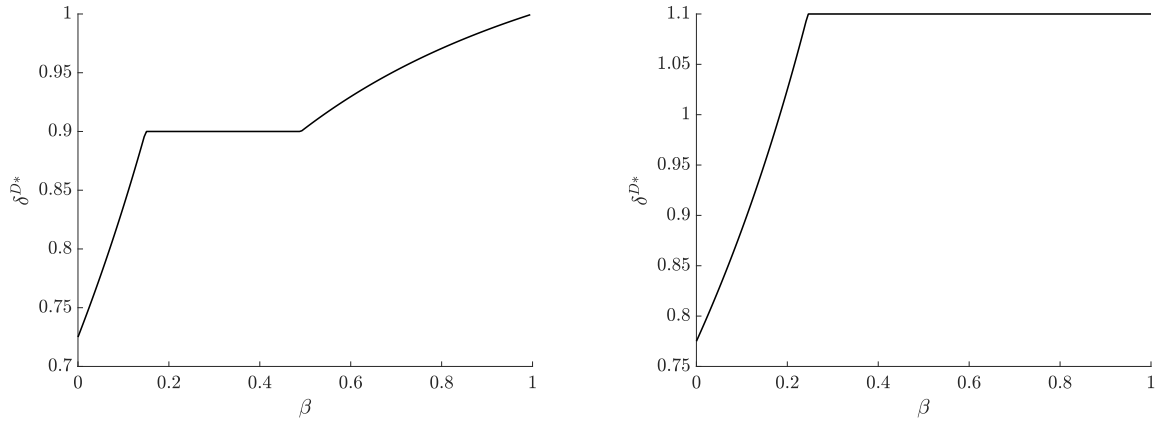
Panel (a) of Figure 1 illustrates the public policy maker's optimal decision on δ^D when $L = 0.45$. When β is low, the public policy maker is concerned primarily with firm profit and chooses a moderate threshold δ^D. Consider the extreme case of $\beta = 0$. In this case, the public policy maker chooses a threshold $\delta^D = 0.725$. 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 the firms always distort their investment decisions, the magnitude of the distortion, $|\alpha_i - \delta^D|$, is relatively small, which guarantees sufficient firm profit.

In the other extreme case of $\beta = 1$, the public policy maker is only concerned with CSR. It chooses 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 a lot in CSR, the aggregate CSR is maximized.

Furthermore, Proposition 2 demonstrates that when L is small, the policymaker tends to set a higher disclosure threshold compared to when L is large. When L is small, the inefficiency due to overinvestment may be even higher. Therefore, the policy maker would choose δ^D to be even higher to preclude firms with low α_i to invest. That explains why δ^{D*} has three possible solutions when L is small. 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.

3.4 Discrete Disclosure vs. Full Disclosure

Our analysis shows that, compared with no disclosure, both full and discrete disclosure incentivize firms to invest in CSR, thereby benefit both firms and the whole society. However, it remains unclear which of the two disclosure policies are more effective from the public policy maker's perspective. We compare the policy maker's payoff under the two disclosure regimes and summarize the results in the following proposition.



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

Figure 1: Optimal threshold under discrete disclosure

Proposition 3 (Discrete disclosure vs. Full disclosure)**.** *When the public policy maker is concerned primarily with firm profit, i.e., when β is low enough, she prefers full disclosure over discrete disclosure; when she is concerned primarily with CSR, i.e., when β is high enough, she prefers discrete disclosure over full disclosure.*

Proposition 3 uncovers the main finding of our paper: the public policy maker prefers discrete disclosure over full disclosure when she is sufficiently concerned about CSR investments. The rationale is that, as outlined in Proposition 1, when the disclosure threshold is high but not too high, firms will be incentivized to overinvest in CSR. Even though such overinvestment in CSR reduces their financial returns, it is still more profitable than the alternative option of not making an investment at all. As for public policy makers, overinvestment reduces the firms' profit but increases aggregate CSR, which is preferred when they place a high weight on CSR.

Figure 2 illustrates the result of Proposition 3. It can be seen that, when β is low, the public policy maker's payoff is higher under full disclosure, under which firms make their CSR investment efficiently; when β is high, the public policy maker's payoff is higher under discrete disclosure, under which the majority of firms overinvest in CSR. Such improvements can be substantial. For instance, when $L = 0.45$ and $\beta = 1$, the public policy maker's payoff is $\Pi^C = 0.725$ under full disclosure, whereas her payoff is $\Pi^D \approx 0.909$ under discrete disclosure, a striking 25.4% improvement. This result showcases the significant role that disclosure policy plays in incentivizing CSR

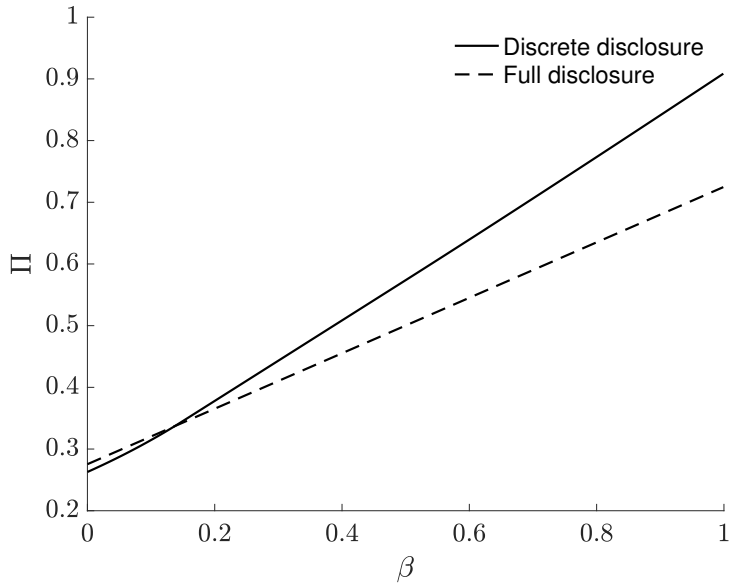


Figure 2: Discrete vs. Full Disclosure ($L = 0.45$)

investment.

4 Multiple Levels for Discrete Disclosure

In the basic model, we assume that there is a single disclosure level under discrete disclosure, e.g., the firm either passes or fails the certification. However, in practice, public policy makers often adopt a refined disclosure policy. For instance, the European Union's energy label provides consumers with information on the energy efficiency of the products. This label classifies products into seven grades ranging from A to G.[10] Likewise, the MSCI ESG Ratings assign firms into seven categories spanning from AAA to CCC.[11] The Ministry of Health of Singapore implements a Nutri-Grade labelling requirement for beverages sold in Singapore, grading beverages into four categories ranging from A to D.[12]

In this section, we consider the effect when discrete disclosure can have more than one level. For the sake of tractability, we consider two levels of disclosure and assume that $L = 0$. Our

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

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.

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:*

$$s_i^M = \begin{cases} 0 & \text{if } \alpha_i < \frac{\delta_1^M}{2}, \\ \delta_1^M & \text{if } \frac{\delta_1^M}{2} \leq \alpha_i \leq \frac{\delta_1^M + \delta_2^M}{2}, \\ \delta_2^M & \text{otherwise.} \end{cases} \tag{8}$$

That is, firms with low marginal returns to CSR do not make any investment; firms with moderate marginal returns to CSR also make a moderate investment in CSR by choosing $s_i^M = \delta_1^M$; firms with high marginal returns to CSR make a high investment in CSR by choosing $s_i^M = \delta_2^M$.

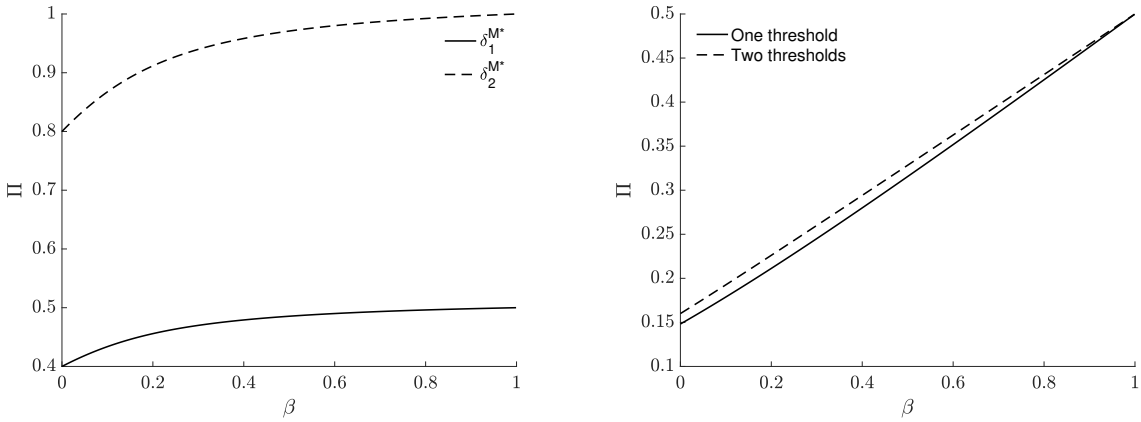
Next, we investigate the public policy maker's optimal choice of the disclosure thresholds. We relegate the analysis to the appendix and present the results in the following proposition.

Proposition 4 (Optimal threshold under multiple disclosure)**.** *With multiple disclosure thresholds, the public policy maker'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 optimal thresholds change with β. Similar to the basic model, as β increases, the public policy maker cares more about CSR. In response, she sets higher thresholds δ_1^M and δ_2^M, which encourages firms with moderate and high marginal returns to CSR to invest more aggressively in CSR.

Panel (b) of Figure 3 shows the effect of having multiple thresholds on the public policy



(a) Optimal thresholds

(b) The effect of multiple thresholds

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

maker's payoff. It follows immediately that the public policy maker is always better off when adopting more disclosure thresholds. The intuition is as follows. When there is only one disclosure threshold (discrete disclosure), firms with either low or high marginal returns to CSR can underinvest in CSR; even though they would like to make a higher investment and benefit from it, they are not able to communicate such investment to stakeholders due to the binary nature of the disclosed information. With multiple disclosure thresholds, however, firms can more easily match the disclosure threshold with their marginal benefit from CSR investments, which alleviates the issue of underinvestment. As a result, both firm profits and CSR increase, which increases the public policy maker's payoff.

5 Censored Disclosure

In the basic model, we show that, when the public policy maker is sufficiently concerned with CSR (i.e., when β is high enough), she prefers discrete disclosure over full disclosure. Nonetheless, discrete disclosure also generates inefficiencies as firms sometimes underinvest: On the one hand, underinvestment reduces the firms' profitability. On the other hand, it also reduces the aggregate CSR investment, thereby hurting both the firm and the society. In this section, we consider an alternative type of disclosure, censored disclosure, which reduces the inefficiency caused

by underinvestment and improves the public policy maker's payoff.

Mathematically, consider the following disclosure policy. Similar to the discrete disclosure regime, the public policy maker 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 will be disclosed, i.e., $s_i^C = \emptyset$. If, however, the firm's CSR investment is equal to or greater than the threshold δ^C, the firm discloses truthfully its CSR investment to the stakeholders. That is,

$$I_i^C = \begin{cases} \emptyset & \text{if } \ s_i < \delta^C, \\ s_i^C & \text{otherwise.} \end{cases} \tag{9}$$

Censored disclosure can be viewed as the hybrid of nondisclosure and full disclosure: Nondisclosure is adopted when the firm's CSR investment is low, whereas full disclosure is implemented when its CSR investment is high.

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

$$s_i^C = \begin{cases} 0 & \text{if } \ \alpha_i < \frac{\delta^C}{2}, \\ \delta^C & \text{if } \ \frac{\delta^C}{2} \leq \alpha_i < \delta^C, \\ \alpha_i & \text{otherwise.} \end{cases} \tag{10}$$

The firm's investment strategy in Equation (10) 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 investment in CSR at all, as the firm cannot afford investing 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 more than the threshold to benefit more from its investment.

Consider next the public policy maker's optimal decision on the disclosure threshold δ^C.

Straightforward algebra yields that, when $L \leq 0.5$, the public policy maker's payoff is

$$\Pi^C = \begin{cases} \frac{1+2\beta+L(1+L+2\beta-L\beta)}{6} & \text{if } \delta^C \leq L, \\ \frac{1-3L^2\delta^C+3L(\delta^C)^2-(\delta^C)^3+\beta(2+\delta^C(3L^2-3L(2+\delta^C)+\delta^C(3+\delta^C)))}{6(1-L)} & \text{if } L \leq \delta^C \leq 2L, \\ \frac{4-(\delta^C)^3+\beta(8+(\delta^C)^3)}{24(1-L)} & \text{if } 2L \leq \delta^C \leq 1, \\ \frac{\delta^C(2-\delta^C)(2+2\beta-\delta^C+\beta\delta^C)}{8(1-L)} & \text{if } 1 \leq \delta^C \leq 2, \\ 0 & \text{if } \delta^C > 2. \end{cases} \tag{11}$$

When $L \geq 0.5$, the public policy maker's payoff is

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

We then investigate the public policy maker'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 policy maker's optimal disclosure threshold is*

$$\delta^{C*} = \begin{cases} L + \frac{2\beta}{1-\beta} & \text{if } \beta < \frac{L}{2+L}, \\ 2L & \text{otherwise.} \end{cases} \tag{13}$$

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

$$\delta^{C*} = \begin{cases} L + \frac{2\beta}{1-\beta} & \text{if } \beta < \frac{1-L}{3-L}, \\ \frac{1+L+\beta-L\beta}{2-2\beta} & \text{if } \frac{1-L}{3-L} \leq \beta \leq \frac{3L-1}{3L+1}, \\ 2L & \text{otherwise.} \end{cases} \tag{14}$$

The following proposition summarizes the implications of censored disclosure for the policy maker.

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

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

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

Part (1) of Proposition 5 demonstrates that the policy maker consistently prefers censored disclosure over full disclosure. This preference is intuitive: by establishing a zero disclosure threshold, censored disclosure can effectively replicate full disclosure. Consequently, the policy maker'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 policy maker's overall payoff.

Part (2) of Proposition 5 shows that for the policy maker prefers censored disclosure over discrete disclosure. The intuition is as follows. With discrete disclosure, firms with high marginal return to CSR underinvests. More specifically, consider a firm with $\alpha_i > \delta^D$. If the firm could disclose directly to stakeholders its CSR investment, it chooses an investment intensity 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 the firm's profit and the CSR investment. With censored disclosure, the firm can now accurately communicate its investment level to stakeholders, and no longer need to distort its investment decision downward. Such an improvement improves both firm profit and CSR level, thereby benefiting the public policy maker.

6 Empirical and Policy Implications

Our results provide several empirical and policy implications. First, we show that while disclosing CSR investments is always better than not disclosing, full disclosure can be worse than discrete disclosure, in particular for policy makers who put more weight on externalities and want to promote more CSR investment. This provides both a justification for some CSR disclosure and a justification not to provide a detailed CSR disclosure, in particular when some CSR disclosures, such as Level 3 green-house gas emissions, cannot be measured perfectly. The discrete disclosure also provides justifications for the reliance of regulators on discrete CSR ratings such as the ESG ratings provided by ESG book or MSCI ESG ratings. As discussed before, our justification of discrete disclosure is different from continuous but noisy measurements of CSR investments as the latter results in severe underinvestment.

Second, we show that, even if CSR investments can be measured precisely, censored disclosure, by reducing underinvestment for firms with high marginal return to CSR investments, is better than discrete disclosure and thus will be better than full disclosure if the policy maker cares sufficiently about CSR. To the extent that the disclosure threshold corresponds to materiality threshold, this result provides a justification for disclosure of CSR investment only if the amount of such CSR investment passes some materiality threshold, as discussed in, e.g., Khan et al. (2016) and Grewal et al. (2019).

Finally, our comparative statics results on disclosure threshold provide some empirical implications on how the materiality threshold should vary with exogenous parameters. For example, perhaps counterintuitively, the disclosure threshold above which firm discloses increases (i.e., there is less disclosure or a higher proportion of firms with suboptimal CSR performance) when the policy maker cares more about externalities and CSR. This is due to policy maker increasing disclosure threshold to alleviate underinvestment. Thus, a higher proportion of firms with suboptimal CSR performance is also associated with more overall investment in CSR but such investment will be more concentrated in firms that have a higher return from CSR or, to the extent that α_i is also a proxy for CSR preference of investors for firm i, firms that have a higher

proportion of CSR investors.

7 Conclusion

Modern firms are increasingly investing in CSR activities to improve the benefits of their stakeholders. When engaging in CSR projects, firms also need to disclose their CSR investments to enjoy the benefit of CSR (e.g., better brand image and consumer satisfaction). Different disclosure standards exist for CSR disclosure, with some disclosing every detailed information about firms' CSR engagements whereas others simply assigning a firm's CSR engagements into a few discrete categories.

In this paper, we build a game-theoretical model to understand the role of disclosure standards in firms' CSR investment and the ensuing benefit to the whole society. We consider three disclosure regimes. Under nondisclosure, firms cannot disclose anything to their stakeholders; under full disclosure, firms disclose all their CSR engagement to their stakeholders; under discrete disclosure, firms only disclose whether their CSR investment passes a certain threshold. We further endogenize firms' CSR investment decisions to investigate how disclosure standards affect such decisions.

We find that disclosure policy has significant effects on firms' incentive to engage in CSR. More specifically, under a discrete disclosure policy, a firm only chooses between making no CSR investments or making investments at the threshold level. Therefore, a firm can overinvest or underinvest in CSR under discrete disclosure. Taking this into consideration, public policy makers can carefully choose a threshold to induce the desired CSR investment by firms. When the public policy maker is primarily concerned with CSR, we show that a discrete disclosure policy is optimal, as it induces more CSR efforts by firms. Collectively, these results suggest the non-trivial role that disclosure standards play and caution public policy makers to take the firms' strategic response into consideration when designing their disclosure policies. More precise disclosure is not necessarily better, in particular when there are large positive externalities from CSR invest-

ments so policy makers care more about inducing higher level of such investments.

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 (2) 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 (4) and (5), 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 (5) we always have $\delta^D = 2L$ for the moderate threshold. Thus, the optimal threshold is determined by equation (4). 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 policy maker 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 policy maker 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 policy maker can achieve an aggregate CSR at:

$$\Delta^D = \begin{cases} \frac{1}{2(1-L)} & \text{if } L \leq \frac{1}{2}, \\ 1 & \text{otherwise,} \end{cases} \tag{15}$$

which is always greater than $\Delta^F = \frac{1+L}{2}$. Note that the aggregate CSR in Equation (15) is just a lower bound for aggregate CSR as the public policy maker can potentially do better by charging a different δ^D. Therefore, the public policy maker must be better off with discrete disclosure.

Finally, because both Π^D and Π^F are continuous, we prove that the public policy maker 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 policy maker'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 policy maker'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 policy maker's payoff is given by equation (11); noting that Region 4 is empty. Examining the policy maker'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 policy maker's payoff is given by equation (12); 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 policy maker'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 policy maker's payoff functions (11) and (12), setting a low threshold (i.e., $\delta^C \leq L$) allows the policy maker to achieve a payoff equivalent to that under full disclosure, i.e., 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

$$s_i^{D*} = \begin{cases} 0 & \text{if } \alpha_i < \frac{\delta^{D*}}{2}, \\ \delta^{D*} & \text{otherwise.} \end{cases} \tag{16}$$

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

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

Comparing Equations (16) and (17), 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 policy maker must also be better off with censored disclosure. Note that when the public policy maker 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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