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Disclosure policy choices under regulatory threat

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This article shows that firms "voluntarily" increase their disclosures in response to the threat of more stringent disclosure regulations. These disclosures are mostly just sufficient to deter regulation. However, when investment risk is low, both managers and investors might strictly prefer the regulation deterring equilibrium. We further find that in many cases, regulation can only be deterred by asymmetric disclosure behavior of the firms. This suggests that coordination issues and free-riding may be important reasons why self-regulation may fail. The results also indicate the importance of considering political pressure and regulatory threats to explain observed symmetric and asymmetric voluntary disclosure behavior.

1. Introduction

■ In resolving inefficiencies in the market, regulation by government or any other authority is a costly solution which consumes much time and resources. Alternatively, threatening to regulate may be sufficient to induce the desired behavior by market participants. In this article, we develop a model to study the disclosure behavior of firms when they face the threat of more stringent regulation. Such threat may induce market participants to self-regulate their industry. Firms can try to avert regulation by "voluntarily" moving toward the desired behavior.

These tensions between desired and current behavior are abundantly present in corporate disclosure, where managers' potential benefits of information asymmetry and investors' information needs conflict. Consider, for example, the discussions on insufficient transparency of the hedge fund industry. In 2007, former Securities and Exchange Commission (SEC) head Harvey Pitt stated in a conference of Certified Public Accountants (CPAs) that "Regulation of hedge funds is on the horizon. The only question is whether that regulation will come from the government or

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from hedge funds themselves."[1] Although a so-called self-regulatory organization (SRO) under government oversight is an option to make regulation more efficient (GAO, 2011), hedge funds failed to avert regulation by increasing their transparency and disclosure (e.g., Dodd-Frank Act in the United States and the Alternative Investment Fund Managers Directive [AIFMD] in Europe).

Executive compensation presents another example. Investors have long since asked for more information on executive compensation packages, but firms have failed to provide this information in a sufficient manner. In the United States, this has led to ever-increasing disclosure regulation by the SEC. Starting in 1992 with a mandatory report justifying the firm's compensation policies, several amendments prescribing additional mandatory disclosures have followed over time, with the most recent one being the SEC's proposal on pay-for-performance disclosures.

Regulatory threat has proven partly effective in other settings, though. In the early 1990s, environmental liability disclosures did improve under regulatory threat by the SEC. However, the disclosures remained insufficient and additional regulation was introduced in 1996 (for more details, see, e.g., Barth, McNichols, and Wilson, 1997; Alciatore, Callaway Dee, and Easton, 2004). Other examples include corporate governance codes and corporate social responsibility disclosures. Corporate governance codes have been a product of self-regulation in many countries. Also, until now, most corporate social responsibility disclosures are voluntary and initiatives with respect to integrated reporting are self-regulated. The industry has kept off regulation so far.

This article analyzes whether firms, when facing a threat of disclosure regulation, can forestall government regulation by voluntarily increasing disclosure and thereby increasing investor welfare. Contrary to several related articles (e.g., Leland, 1979; Gehrig and Jost, 1995; DeMarzo, Fishman, and Hagerty, 2005), we do not consider an SRO but focus on sustainable equilibrium strategies without active enforcement by the industry itself.

This article considers a setting in which firms may have an incentive not to disclose information, whereas potential investors benefit from more disclosure. Firms have many reasons for not or only partly disclosing relevant information (see, e.g., Verrecchia, 1983; Dye, 1985; Penno, 1997; Pae, 2005). The reason for nondisclosure or partial disclosure in this article is investor response uncertainty as, for example, in Dye (1998), Dutta and Trueman (2002), and Suijs (2007).[2] The setting that we employ to achieve nondisclosure or partial disclosure in an unregulated setting is comparable to Suijs (2007). The misalignment of interests between firms and investors creates a demand for disclosure regulation.[3]

We model a financial market with two investment opportunities, for example, mutual funds or firms, who compete for the investors' capital. The investors can choose between investing in the firms or in some outside investment opportunity (e.g., risk-free asset). To attract capital, firms may voluntarily disclose (noisy) information about their future return. Each investment opportunity can be either a success or a failure. In the unregulated setting, equilibrium strategies exist in which no or little information is disclosed in equilibrium, but disclosure regulation, which we assume to be costly, can increase investor welfare. We show that in such circumstances, a threat of regulation may induce firms to disclose more information. For high-risk investments, that is, investments with a relatively low probability of success, we find that firms' disclosure policies are just informative enough to avert disclosure regulation, that is, the additional increase in investors' welfare of disclosure regulation cancels out against the cost of disclosure regulation. In the aforementioned conference of CPAs, Harvey Pitt said: "If the hedge fund industry is able to realize that the benefits of self-regulation outweigh their costs, for a few dollars more the industry can protect itself from unwelcome government intervention. Absent any concrete suggestions from hedge funds . . . legislators and regulators will be happy to propose their own solutions, no

[1] www.reuters.com/article/idUSN1626114020070517 : "Former SEC head urges hedge funds to self-regulate," May 17, 2007.

[2] See Beyer, Cohen, Lys, and Walther (2010) for more details on this reason for the unraveling argument not to hold.

[3] For studies that focus on the demand for disclosure regulation, see, for example, Dye (1990), Suijs and Wielhouwer (2014), or Vives (1984).

matter how impractical."[4] In these cases, the lower the cost of regulation per unit invested, the more informative the disclosures must be to deter regulation.

We find that two types of regulation deterring disclosure equilibria may arise: a symmetric disclosure equilibrium, where both firms' disclosures are equally informative, and an asymmetric disclosure equilibrium, where one firm makes a more informative disclosure than the other. The symmetric equilibria are generally possible when the cost of regulation is high. For lower cost levels, regulation can only be deterred by asymmetric disclosure, which may give rise to a coordination problem. When firm managers are less averse to volatility in investment flows, the range of asymmetric equilibria increases at the expense of symmetric equilibria. Furthermore, for medium-to low-risk investments, that is, investments with an intermediate probability of success, the asymmetric regulation deterring equilibria may feature full disclosure. Such full disclosure is more than strictly necessary to deter regulation so that the net welfare benefits are strictly higher under regulatory threat than under regulation. The explanation is that full disclosure maximizes the likelihood of generating the good report, whereas the other firm is better off making limited disclosures so as to prevent the investor from investing in the alternative investment opportunity.

Our findings provide some useful insights into self-regulatory processes. First, the outcome of self-regulation remains socially inefficient. Full disclosure, which maximizes investor welfare, will not be achieved without costs of regulation. However, whereas DeMarzo, Fishman, and Hagerty (2005) find that the benefits of government intervention always cancel out against the cost of it, we find that the threat of regulation can make investors strictly better off than regulation itself.[5] Second, authorities facilitating the process of self-regulation need not always focus on getting the complete industry involved. In case of an asymmetric regulation deterring disclosure equilibrium, it suffices when only several firms, preferably the market leaders, sign up to the self-regulation. Third, self-regulation could fail because of a coordination problem, as nondisclosing firms may free-ride: in an asymmetric regulation deterring equilibrium, one firm is better off than the other. Finally, the results provide insight in when self-regulation is likely to succeed and thus whether threatening with regulation is effective.

Our findings also provide a possible alternative explanation for observed voluntary disclosures. Some voluntary disclosures may not be truly voluntary but instead be driven by a threat of disclosure regulation. Consider, for example, the voluntary disclosures prior to the introduction of the Securities Exchange Act in 1934. One could interpret these voluntary disclosures as evidence of properly working market forces and therefore as a reason not to impose regulation (see, e.g., Benston, 1969, 1973). An alternative interpretation is that firms made voluntary disclosures to avert more stringent regulation (see, e.g., Merino and Neimark, 1982).

The remainder of the paper is organized as follows. Section 2 discusses related research and Section 3 presents the theoretical model. Section 4 analyzes the setting without any disclosure regulations whereas Section 5 analyzes the setting with regulatory threat. Section 6 discusses the results and Section 7 concludes.

2. Related research

■ The article relates to several streams of research. We study whether regulation can be averted by noncooperative voluntary disclosures, which can be seen as a kind of self-regulation that is not enforced. This is an important difference with early related research on, for example, whether a government should grant power to the industry to set minimum quality levels, which are then enforced by an SRO (e.g., Leland, 1979; Gehrig and Jost, 1995). The absence of an SRO is also

[4] E. Chasan on www.reuters.com/article/idUSN1626114020070517 : "Former SEC head urges hedge funds to self-regulate," May 17, 2007.

[5] Maxwell, Lyon, and Hackett (2000) too find that self-regulation driven by the threat of political intervention can be socially preferable, but this is due to the fact that the costs of influencing policy are not incurred, whereas we do not incorporate such costs.

an important difference with DeMarzo, Fishman, and Hagerty (2005) who study the enforcement strategy of an SRO that faces the risk of government intervention.

In the absence of an SRO, Glazer and McMillan (1992) show theoretically that a monopolistic firm that faces the threat of regulation lowers its prices to avert regulation. Following this theoretical prediction, Ellison and Wolfram (2006) provide empirical evidence of actions in the pharmaceutical industry to avert possible price regulation. Erfle and McMillan (1990) and Stango (2003) study pricing decisions of large firms, following the threat of legislation in the oil and credit card industries, respectively. An important difference between our study and that of Glazer and McMillan (1992) is that we consider two firms, which allows to focus on coordination issues and free-riding problems when trying to avert regulation. This gives rise to possible asymmetric equilibria for symmetric firms. This difference also applies to Maxwell, Lyon, and Hackett (2000) who study whether firms can avert environmental regulation by jointly controlling pollution. Although they consider multiple firms, only symmetric actions are considered.

Related studies on standard setting in financial reporting usually take on a regulator's perspective and primarily focus on the desirability of specific types of accounting standards like conservatism (e.g., Gigler, Kanodia, Sapra, and Venugopalan, 2009; Göx and Wagenhofer, 2009; Caskey and Hughes, 2012; Li, 2013). Bertomeu and Cheynel (2013) and Bertomeu and Magee (2015) analyze the political process of accounting standard setting, whereas Bebchuk and Neeman (2009) and Friedman and Heinle (2013) study the politics and lobbying in the regulatory process related to investor protection. Our study differs from these studies in that we analyze whether the threat of implementing the disclosure rule that investors prefer affects firms' voluntary disclosure policy choices.

In our study, voluntary disclosure is affected by the threat of regulation. Several other recent studies focused on the effects of other types of interactions on voluntary disclosure. Langberg and Sivaramakrishnan (2008) and Langberg and Sivaramakrishnan (2010) analyze how subsequent analysis of information with possibly relevant feedback affect the voluntary disclosures of firms, and Corona and Randhawa (2018) show that an external evaluator that tries to detect mistakes may lead to voluntary confessions of mistakes to build a better long-term reputation.

Finally, we mention that the disclosure setting that we consider can also be seen as a Bayesian persuasion game. These games consider settings in which a sender commits to an information structure before the realization of the information is known in order to increase the probability that the receiver of the information takes a favorable action (e.g., Kamenica and Gentzkow, 2011). We also apply a model in which managers have to commit to a disclosure precision prior to receiving the information, as is quite common in disclosure research in duopolies (e.g., Gal-Or, 1985; Vives, 1984; Raith, 1996; Hughes and Williams, 2008; Bagnoli and Watts, 2015). As shown by Gentzkow and Kamenica (2016), competition may have ambiguous effects on information revelation in persuasion, highlighting the importance of studying the effects of strategic interaction between firms on their disclosure decisions.

3. Model description

■ Consider a capital market with two risky investment opportunities (e.g., firms) and a capital-constrained investor. The representative investor has a limited amount of capital c available for investments. The investor can invest this capital in either (or both) of the two firms or in an alternative investment opportunity (e.g., risk-free asset). The return of the alternative investment opportunity is denoted by $r_0 > 0$. The return of firm $i = 1, 2$ is denoted by $\tilde{r}_i$, and the returns $\tilde{r}_1$ and $\tilde{r}_2$ are identically and independently distributed. The prior beliefs of the investor concerning the return $\tilde{r}_i$ are that $\tilde{r}_i = r_H$ with probability p and $\tilde{r}_i = r_L$ with probability $1 - p$. We assume that $r_L < r_0 < r_H$, and without loss of generality, we assume $r_L = 0$. The investment decision is denoted by $x = (x_0, x_1, x_2)$, where x_0, x_1, and x_2 denote the respective investments in the alternative investment opportunity, firm 1, and firm 2. An investment decision x is feasible when $x_i \geq 0$ and $x_0 + x_1 + x_2 = c$. The constraint $x_i \geq 0$ prohibits short selling, in line with our assumption of constrained capital. The investor is assumed to be risk neutral and maximizes his expected return.

Firm managers simultaneously choose (and announce) a disclosure policy σ_i, with $\sigma_i \in [\frac{1}{2}, 1]$ representing the informativeness of the disclosure that firm i will make. A disclosure policy σ_i generates a (possibly) noisy report $\rho_i \in \{r_L, r_H\}$ on the return of firm i satisfying

$$Pr(\tilde{\rho}_i = r_H | \tilde{r}_i = r_H) = Pr(\tilde{\rho}_i = r_L | \tilde{r}_i = r_L) = \sigma_i. \tag{1}$$

The parameter σ_i determines the probability that the report ρ_i is correct. When $\sigma_i = \frac{1}{2}$, the report is uninformative and when $\sigma_i = 1$, the report is fully revealing. We interpret σ as a measure of informativeness, as it indicates to what extent the report informs investors on the actual return of the firm (cf. Fishman and Hagerty, 1990; Gigler and Hemmer, 2001; Dutta and Gigler, 2002). Observe that a firm has no direct control over which report is disclosed; a firm's disclosure policy choice only controls the accuracy of the report. The actual report that has to be disclosed is generated by nature. The assumption that a firm decides on the disclosure policy before learning the firm's actual return is consistent with self-regulated disclosure. Because self-regulated disclosure standards not only apply to the current period but also to future periods, firm i needs to consider the consequences of a particular disclosure policy σ_i for all possible realizations of the return $\tilde{r}_i$, rather than just the current realization.[6]

The manager of firm i chooses disclosure policy σ_i so as to maximize expected utility from investment received, that is, $E(U(\tilde{x}_i(\sigma_i, \sigma_j)))$. The utility function $U(x)$ is increasing and concave in the amount invested x, allowing the manager to be risk averse. This utility function captures empire building behavior by the manager (e.g., Baldenius, 2003; Hermalin and Weisbach, 2012). We note that this objective may conflict with the firm's best interest. Without loss of generality, we may assume that $U(0) = 0$. Notice that $\tilde{x}_i(\sigma_i, \sigma_j)$ is random, as it depends on the future disclosures $\tilde{\rho}_i$ and $\tilde{\rho}_j$, which in turn depend on the disclosure policies σ_i and σ_j. This uncertainty with respect to investor response to disclosure allows for nondisclosure to be a sustainable equilibrium strategy.[7] For ease of exposition, we assume that disclosure policy choice is costless. Section 6 discusses how our results change when more precise disclosure policies are more costly. We assume that disclosure policy choices are observable, as this may be most in line with a regulator threatening to impose regulation to increase transparency.

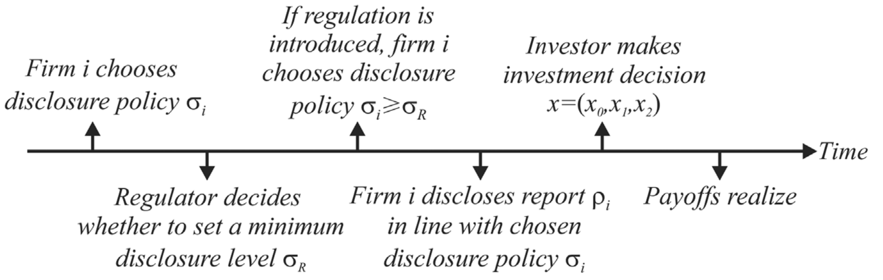
We exclude the option for the investor to contract with the firms' managers on disclosure policy choice. A contracting solution requires a contract between the manager and the potential investors, investors who may at that time have no investments in the firms and may decide not to invest at all. Contracting only seems to work when the investor can offer a contract to the firm *and* the investor can credibly commit not to invest in a firm that rejects the contract. The latter condition is necessary because – as we will show later – the investor finds it optimal to invest in the firms, even when these firms do not make any informative disclosures. The former condition may be problematic for the more realistic setting with many investors rather than a single investor. In that case, a representative of the investor population should contract with the firms. One form of contracting between a firm and her potential investors that one can observe in practice applies to public equity markets, with each market formulating her own stock listing rules prescribing, among other things, a minimum level of financial disclosures. This, however, can also be interpreted as some form of self-regulation, as a public equity market sets the disclosures rules and the firms choose which public equity market to enter. Furthermore, this setting is more representative of the symmetric regulation deterring equilibrium that we discuss in Section 5 than a setting where potential investors contract with firms.

[6] Unconditional disclosure policy choices are quite common in disclosure research on duopoly settings. See, for example, Gal-Or (1985, 1986), Vives (1984, 2002), Raith (1996), Hughes and Williams (2008), Bagnoli and Watts (2010, 2015).

[7] It is crucial to our analysis that nondisclosure arises in an unregulated setting and that disclosure regulation is desirable. Uncertainty with respect to investor response achieves this (cf. Dye, 1998; Dutta and Trueman, 2002; Suijs, 2007).

FIGURE 1

SEQUENCE OF EVENTS



The sequence of events is as follows (cf. Figure 1). Firms (i.e., their managers) first simultaneously choose their disclosure policy σ_i. Then, the regulator decides whether to set a minimum disclosure standard and firms respond to that by subsequently adjusting their disclosure policies. Note that we do not consider this decision of the regulator (and the adjustment in disclosure policies) until Section 5, and first consider the benchmark case in which this decision is absent in Section 4. Then, firms publicly disclose a (noisy) financial report ρ_i in line with the chosen disclosure policy σ_i. The investor observes the financial reports ρ_i and their informativeness σ_i and subsequently makes his investment decision. Finally, the payoffs realize.

In order to focus on settings where nondisclosure may be optimal, we assume that without disclosure, the expected payoff of investing in firm i (i.e., of the risky investment) is higher than the (certain) payoff of the outside option, implying that

$$pr_H > r_0. \tag{2}$$

4. Unregulated disclosures

■ This section analyzes disclosure policy choices in the absence of disclosure regulation or any threat thereof. We first derive the optimal investment decision $x^* = (x_0^*, x_1^*, x_2^*)$, given all possible disclosure policies after which the Nash equilibrium disclosure policies can be determined.

□ **Optimal investments and investor welfare.** The investment decision x_i of the investor depends on the expected return, which is updated based on the disclosed reports $\tilde{\rho}_i$ and $\tilde{\rho}_j$ and the disclosure policies σ_i and σ_j. What is particularly important for our setting is when the investor prefers investing in the alternative investment opportunity over investing in firm i, that is, when $E(\tilde{r}_i|\rho_i) < r_0$. Because prior beliefs satisfy $E(\tilde{r}_i) > r_0$ by assumption (2), the investor prefers the alternative investment opportunity over firm i only when firm i has disclosed a bad report *and* this bad report $\rho_i = r_L$ is sufficiently informative, so that $E(\tilde{r}_i|\tilde{\rho}_i = r_L) = \frac{p(1-\sigma_i)r_H}{p(1-\sigma_i)+(1-p)\sigma_i} < r_0$, that is, the disclosure policy σ_i exceeds the threshold value $\sigma^*(p) = \frac{p(r_H - r_0)}{p(r_H - r_0)+(1-p)r_0}$. For ease of exposition, we regularly write σ^* instead of $\sigma^*(p)$ when there is no confusion about the argument p.

Table 1 summarizes the optimal investment decisions. Because of risk neutrality, the investor will invest all his capital in the alternative with the highest expected return. This implies that if only one firm has reported good news (r_H), the investor invests in that firm. If both firms have reported good news, the investor invests in the firm with the most informative disclosure policy, as this firm is more likely to yield the high return. When the reports are equally informative, the capital is allocated equally among the two firms. If both firms have reported bad news, the investor prefers the firm with the least informative disclosure policy over the firm with the more informative disclosure policy, as the report of the former firm is more likely to be wrong. Whether

TABLE 1 Optimal Investment Decision (x_i^*, x_j^*) as a Function of Observed Reports ρ_i and ρ_j and Disclosure Policies σ_i and σ_j

Case:	I	II	III	IV
(ρ_i, ρ_j)	$\sigma_i = \sigma_j$ $\sigma_i \leq \sigma^*$	$\sigma_i = \sigma_j$ $\sigma_i > \sigma^*$	$\sigma_i > \sigma_j$ $\sigma_j \leq \sigma^*$	$\sigma_i > \sigma_j$ $\sigma_j > \sigma^*$
(r_L, r_L)	$(\frac{1}{2}c, \frac{1}{2}c)$	$(0, 0)$	$(0, c)$	$(0, 0)$
(r_L, r_H)	$(0, c)$	$(0, c)$	$(0, c)$	$(0, c)$
(r_H, r_L)	$(c, 0)$	$(c, 0)$	$(c, 0)$	$(c, 0)$
(r_H, r_H)	$(\frac{1}{2}c, \frac{1}{2}c)$	$(\frac{1}{2}c, \frac{1}{2}c)$	$(c, 0)$	$(c, 0)$

the investor will invest in the firm with the least informative disclosure policy depends on whether the informativeness is sufficiently low, that is, less than σ^*. If it is, the investor assigns little weight to the financial report, so that he still invests all his capital in this particular firm. If it is not, he prefers investing in the alternative investment opportunity. Therefore, when the bad financial reports are equally informative and the informativeness is less than σ^*, the capital is again equally allocated to the two firms. If the informativeness exceeds σ^*, everything will be invested in the alternative investment opportunity.

Let $ER(\sigma_i, \sigma_j)$ denote the expected return of the investor *per unit of investment* given the disclosure policies σ_i and σ_j. The total expected return then equals $c \cdot ER(\sigma_i, \sigma_j)$. Let $\pi(\sigma) = p\sigma + (1-p)(1-\sigma)$ denote the probability that disclosure policy σ generates the good report. It holds that[8]:

$$ER(\sigma_i, \sigma_j) = pr_H(p + 2\sigma_i(1-p)) \tag{3}$$

if $\sigma_i \geq \sigma_j$ and $\sigma_j \leq \sigma^*$; and

$$ER(\sigma_i, \sigma_j) = pr_H\left(\sigma_i + (1-\pi(\sigma_i))\sigma_j\right) + (1-\pi(\sigma_i))(1-\pi(\sigma_j))r_0 \tag{4}$$

if $\sigma_i \geq \sigma_j > \sigma^*$.

The investor's expected return is increasing in the disclosure policies because more precise information enables the investor to better identify the investment opportunity with the highest return. Observe, though, that for $\sigma_j \leq \sigma^*$, the investor's expected return depends only on the most informative disclosure policy σ_i. The explanation for this is as follows. When $\sigma_i > \sigma_j$ (i.e., case III in Table 1), the investor's decision depends only on the most informative report $\tilde{\rho}_i$: he invests in firm i when firm i's report is good, and he invests in firm j when firm i's report is bad. The least informative report σ_j is irrelevant, because $\sigma_j \leq \sigma^*$: the investor's posterior beliefs regarding the return of firm j satisfy $E(\tilde{r}_j|\rho_j) \geq r_0$, irrespective of what report firm j discloses. Hence, investing in firm j is always preferred over investing in the alternative investment opportunity. When $\sigma_i = \sigma_j$ (i.e., case I in Table 1), the investor's decision does depend on both reports, but because they have equal precision, expected return depends only on σ_i $(= \sigma_j)$.

We emphasize that the investor's expected return is increasing in the disclosure precision of either the most informative report or both reports. Investor welfare is thus increasing with disclosure even when the investor never invests in the outside option. Observe that because the fully informative equilibrium maximizes the investor's expected return, a demand for disclosure regulation may arise whenever a nondisclosure or partially informative disclosure equilibrium arises.

[8] The following equations follow from straightforward calculations. Consider, for example, cases I and IV. In case I, $\sigma_i = \sigma_j = \sigma \leq \sigma^*$. It then follows that $ER(\sigma_i, \sigma_j) = \pi(\sigma)^2[0.5E(\tilde{r}_i|r_H) + 0.5E(\tilde{r}_j|r_H)] + \pi(\sigma)[1-\pi(\sigma)]E(\tilde{r}_i|r_H) + \pi(\sigma)[1-\pi(\sigma)]E(\tilde{r}_j|r_H) + [1-\pi(\sigma)]^2[0.5E(\tilde{r}_i|r_L) + 0.5E(\tilde{r}_j|r_L)]$. For case IV, $\sigma_i > \sigma_j > \sigma^*$. Given the optimal investment decisions, the expected return then equals $ER(\sigma_i, \sigma_j) = \pi(\sigma_i)E(\tilde{r}_i|r_H) + [1-\pi(\sigma_i)]\pi(\sigma_j)E(\tilde{r}_j|r_H) + [1-\pi(\sigma_i)][1-\pi(\sigma_j)]r_0$.

TABLE 2 Expected Utility for the Manager of firm i when Disclosure Policies are σ_i and σ_j. Cases I–IV Correspond to the Cases I–IV Defined in Table 1

Case:	disclosure	$\frac{1}{U(c)} \cdot E(U(x_i))$	$\frac{1}{U(c)} \cdot E(U(x_j))$
I	$\sigma_i = \sigma_j, \sigma_i \leq \sigma^*$	$(1 - \pi(\sigma_i) + \pi(\sigma_i)^2)$ $-u(1 - 2\pi(\sigma_i) + 2\pi(\sigma_i)^2)$	$(1 - \pi(\sigma_i) + \pi(\sigma_i)^2)$ $-u(1 - 2\pi(\sigma_i) + 2\pi(\sigma_i)^2)$
II	$\sigma_i = \sigma_j, \sigma_i > \sigma^*$	$\pi(\sigma_i)(1 - \pi(\sigma_i)u)$	$\pi(\sigma_i)(1 - \pi(\sigma_i)u)$
III	$\sigma_i > \sigma_j, \sigma_j \leq \sigma^*$	$\pi(\sigma_i)$	$(1 - \pi(\sigma_i))$
IV	$\sigma_i > \sigma_j, \sigma_j > \sigma^*$	$\pi(\sigma_i)$	$\pi(\sigma_j)(1 - \pi(\sigma_i))$

□ **Optimal disclosure policies.** Given the optimal investment decision, we can derive the expected utility for manager i, given disclosure policies σ_i and σ_j. The expected utility depends on the relative values of σ_i and σ_j and is presented in Table 2 for each of the four possible disclosure policy combinations from Table 1. The parameter u is defined as $u = \frac{U(c)-U(\frac{1}{2}c)}{U(c)}$ and measures the degree of risk aversion of the manager. It holds that $u \in (0, \frac{1}{2}]$ and higher values of u imply a lower degree of risk aversion. In particular, $u = \frac{1}{2}$ corresponds to risk neutrality.

Disclosure policies $\hat{\sigma}_i$ and $\hat{\sigma}_j$ constitute a Nash equilibrium when for each manager i, disclosure policy $\hat{\sigma}_i$ maximizes expected utility given the disclosure policy $\hat{\sigma}_j$ of manager j, that is, $E(U(\tilde{x}_i(\hat{\sigma}_i, \hat{\sigma}_j)) = \max_{\sigma_i} E(U(\tilde{x}_i(\sigma_i, \hat{\sigma}_j))$.

The following proposition presents the equilibrium disclosure strategies in the absence of regulation or any threat of regulation. For this, define for $p < \frac{1}{2}$

$$\sigma_H(p) = \frac{1-p}{1-2p} - \frac{1}{(1-2u)(1-2p)}\left(\sqrt{u(1-u)} - u\right), \tag{5}$$

and for $p \geq \frac{1}{2}$, the continuous function

$$\sigma_L(p) = \begin{cases} \frac{1}{2} & \text{for } p < \frac{3}{4} - \frac{1}{2}u, \\ \frac{1}{2} + \frac{1}{2(2p-1)}\sqrt{\frac{2(2p-1)}{1-2u} - 1} & \text{for } p \geq \frac{3}{4} - \frac{1}{2}u. \end{cases} \tag{6}$$

Further, define

$$p_H(\sigma) = -\frac{1-\sigma}{2\sigma-1} + \frac{1}{(1-2u)(2\sigma-1)}\left(\sqrt{u(1-u)} - u\right) \tag{7}$$

$$p_L(\sigma) = \frac{1}{2} + \frac{1}{2(1-2u)(2\sigma-1)^2}\left(1 - \sqrt{1-(1-2u)^2(2\sigma-1)^2}\right) \tag{8}$$

$$p_{FD} = \frac{1}{u}\left(1 - \sqrt{1-u}\right). \tag{9}$$

Observe that $\sigma_H(p) \geq \frac{1}{2}$, $\sigma_L(p) \geq \frac{1}{2}$ and that both $\sigma_H(p)$ and $\sigma_L(p)$ are increasing in p. Further, observe that $p_H(\sigma)$ and $p_L(\sigma)$ are the inverse functions of $\sigma_H(p)$ and $\sigma_L(p)$, respectively. It holds that $p_H(\sigma) < \frac{1}{2} < p_L(\sigma)$. Finally, define $\overline{p} \in [\frac{1}{2}, 1]$ as the unique solution of $p = p_L(\sigma^*(p))$.

Proposition 1. In an unregulated setting, the following Nash equilibria exist:

A $(\hat{\sigma}_1, \hat{\sigma}_2) = (\sigma, \sigma)$ with $\frac{1}{2} \leq \sigma \leq \min(\sigma^*(p), \sigma_H(p))$ if and only if $r_0/r_H \leq p < \frac{1}{2}$;
B $(\hat{\sigma}_1, \hat{\sigma}_2) = (\sigma, \sigma)$ with $\sigma_L(p) \leq \sigma \leq \sigma^*(p)$ if and only if $\frac{1}{2} \leq p \leq \overline{p}$;
C $(\hat{\sigma}_1, \hat{\sigma}_2) = (1, 1)$ if and only if $p \geq p_{FD}$.
D A mixed strategy where firm $i = 1, 2$ mixes between disclosure policies $\sigma_i = \sigma^*(p)$ and $\sigma_i = 1$ if and only if $\overline{p} \leq p \leq p_{FD}$.

All proofs are in Appendix A. Proposition 1 states that only symmetric equilibria exist, that is, both firms choose the same disclosure policy. An equilibrium can be uninformative (i.e.,

$\hat{\sigma}_i = \hat{\sigma}_j = \frac{1}{2}$), partially informative (i.e., $\hat{\sigma}_i = \hat{\sigma}_j = \sigma > \frac{1}{2}$), or fully revealing (i.e., $\hat{\sigma}_i = \hat{\sigma}_j = 1$). Existence of a particular disclosure equilibrium depends on the *ex ante* success probability p.

The intuition for the equilibrium strategies is as follows. In a symmetric equilibrium, the capital that firm i acquires equals either c, $\frac{1}{2}c$, or zero. In contrast, when firm i deviates to a nonequilibrium disclosure policy, the capital that firm i acquires equals either c or zero. Roughly speaking, the potential benefit of the nonequilibrium disclosure policy is that the likelihood of acquiring all of the investor's capital c may be higher; the cost is the increased volatility in the acquired amount of capital. A risk-averse manager values the equal sharing of the investor's capital.

Let us start by providing the intuition behind the upper bound σ^* for not fully revealing pure-strategy equilibria. An equilibrium with $\sigma_i = \sigma_j > \sigma^*$ and $\sigma_i = \sigma_j < 1$ is never sustainable. In such case, firm i acquires capital from the investor only when firm i generates the good report; firm i does not acquire any capital when she generates the bad report. Therefore, firm i benefits from deviating to a marginally more informative disclosure policy. Such a deviation does not materially affect the likelihood of generating the good report, but firm i no longer has to share the capital with firm j when both firms generate the good report.

Other lower and upper bounds on σ may be relevant, too. Let us start with part A, where $p < \frac{1}{2}$. For these values of p, *lowering* the disclosure precision of the report increases the probability of the good report. Therefore, only deviations to a lower disclosure precision are possibly valuable. Deviating to a lower disclosure precision is only beneficial for firm i when firm j discloses the bad report, as in that case, all of the investor's capital is acquired. Because this benefit is higher when firm j is more likely to disclose the bad report, the likelihood of firm j disclosing the bad report cannot be too high. This likelihood of disclosing a bad report is increasing in the disclosure precision for $p < \frac{1}{2}$. This explains the upper bound $\sigma_H(p)$: for more informative disclosure policies, it would be optimal to deviate to nondisclosure.

Next, consider part B where $p \geq \frac{1}{2}$. Here, *increasing* the disclosure precision increases the probability of the good report. Therefore, only deviations to a higher precision level are possibly valuable. Deviating to a higher disclosure precision is only beneficial for firm i when Firm j discloses the good report, as in that case, all of the investor's capital is acquired. Because this benefit is higher when firm j is less likely to disclose the good report, the likelihood of firm j disclosing the good report cannot be too low. This explains the lower bound $\sigma_L(p)$.

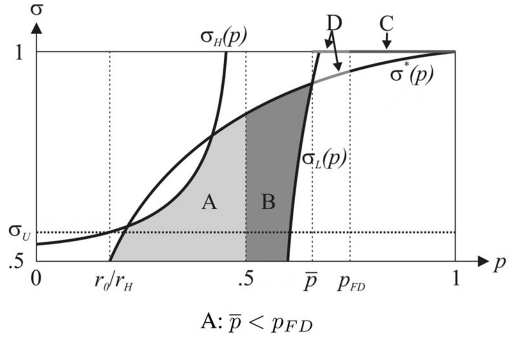
Concerning the full disclosure equilibrium in part C, observe that deviating to a less informative disclosure policy is beneficial to firm i when firm j generates the bad report and it is costly when both firms generate the good report. Clearly, for sufficiently low values of p, the likelihood of firm j generating the bad report is high enough to make such deviations attractive. This explains the lower bound p_{FD}.

Figure 2 illustrates the existence of the symmetric equilibria of Proposition 1. Panel A illustrates the case where $\overline{p} < p_{FD}$, and Panel B illustrates the case where $\overline{p} > p_{FD}$. Figure 2 shows that, for a given value of p, usually multiple equilibria exist; for example, the range $[\max\{0.5; \sigma_L(p)\}, \sigma^*(p)]$ in region B, given a value of p, indicates all possible disclosure strategies σ that constitute a symmetric equilibrium strategy. For $\overline{p} < p_{FD}$, the equilibrium solutions in A–D are mutually exclusive. When $\overline{p} \geq p_{FD}$, the mixed-strategy equilibrium D does not exist. In that case, equilibria B and C exist simultaneously for $p_{FD} \leq p \leq \overline{p}$.

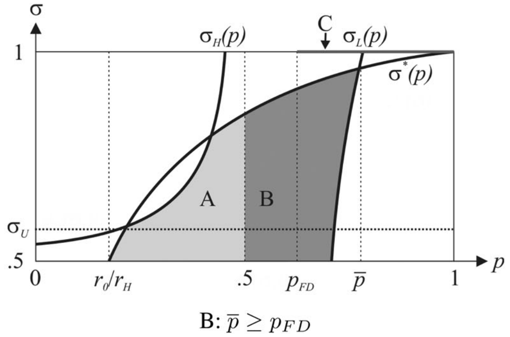
The multiplicity of equilibria is driven by managerial risk aversion. In the extreme case of risk-neutral managers, that is, $u = \frac{1}{2}$, many equilibria cease to exist. For $p < \frac{1}{2}$, the no disclosure equilibrium $(\hat{\sigma}_1, \hat{\sigma}_2) = (\frac{1}{2}, \frac{1}{2})$ is the only equilibrium. The reason for this is that risk-neutral managers do not assign any value to sharing the investor's capital c. Consequently, a manager is better off deviating to a less informative disclosure policy, as this increases the likelihood of generating the good report, which yields all of the investor's capital. Second, for $\frac{1}{2} \leq p \leq p_{FD} = 2 - \sqrt{2}$, the mixed-strategy equilibrium exists, whereas for $p \geq p_{FD} = 2 - \sqrt{2}$, full disclosure is the unique equilibrium. For $p \geq \frac{1}{2}$, the symmetric equilibria $(\sigma_i, \sigma_j) = (\sigma, \sigma)$ with $\sigma \leq \sigma^*$

FIGURE 2

EXISTENCE OF SYMMETRIC DISCLOSURE EQUILIBRIA $(\hat{\sigma}_1, \hat{\sigma}_2) = (\sigma, \sigma)$ AS A FUNCTION OF THE SUCCESS PROBABILITY p. THE LABELS OF THE DIFFERENT AREAS IN THE GRAPH REFER TO PROPOSITION 1 A–D. THE GRAPH ILLUSTRATES ALL POSSIBLE EQUILIBRIUM VALUES OF σ FOR EACH VALUE OF PARAMETER p



A: $\overline{p} < p_{FD}$



B: $\overline{p} \geq p_{FD}$

no longer exist: because risk-neutral managers do not assign any value to sharing the investor's capital c, a manager is better off deviating to a marginally more informative disclosure policy, as this increases the likelihood of disclosing the good report.

Finally, observe that when assumption (2) does not apply, that is $pr_H \leq r_0$, the full disclosure equilibrium arises. Because in this case firms attract no capital when they disclose a bad report, each firm prefers to use a more informative disclosure policy than its competitor, which results in a race to the top.

5. Threat of disclosure regulation

■ We now introduce a regulator who acts in the interests of the investors. When investor welfare is suboptimal, disclosure regulation may be a means to enhance investor welfare. We model disclosure regulation by means of a minimum precision level σ_R that firms need to comply with. Such a minimum precision level increases the likelihood that the report is correct and thus the informativeness of this report to investors, and thereby the investor's expected return. Regulation may only be welfare-enhancing when in the absence of regulation, partial or nondisclosure results. Let σ_U denote the disclosure level that would arise in equilibrium in an unregulated setting. We confine our attention to the pure-strategy equilibria (i.e., equilibria A and B in Proposition 1).[9] Proposition 1 implies that given an unregulated disclosure level σ_U, the following range of values for p are to be considered: $\max(p^*(\sigma_U), p_H(\sigma_U)) \leq p \leq p_L(\sigma_U)$ where $p^*(\sigma) = \frac{\sigma r_0}{\sigma r_0 + (1-\sigma)(r_H - r_0)}$ is the inverse of $\sigma^*(p)$ (cf. Figure 2). For values of p greater than $p_L(\sigma_U)$ or less than $\max(p^*(\sigma_U), p_H(\sigma_U))$, the disclosure policy σ_U could not have resulted as the unregulated equilibrium. Note that because $\sigma_U \leq \sigma^*$, it holds that $p_L(\sigma_U) \leq \overline{p}$. In Figure 2, the dependence of the range of relevant values for p on the given unregulated equilibrium σ_U is indicated by the dotted line $\sigma = \sigma_U$.

For disclosure regulation to be effective, enforcement is required and such enforcement is costly. Regulatory costs can be quite significant. The costs include the cost of introducing new disclosure regulations but also the periodic costs of monitoring compliance with the new regulations. This section analyzes whether threatening with disclosure rules may be an alternative means to enhance investor welfare. The setting is consistent with a setting where a regulator offers the firms the opportunity to self-regulate disclosure. When self-regulation does not succeed or

[9] The deterring strategy for the mixed-strategy equilibrium D is presented in Appendix B and is similar in spirit to one of the resulting asymmetric deterring equilibria.

when the self-regulated disclosures do not meet the regulator's standards, the regulator will impose and enforce the desired disclosure regulations.

The welfare function of the regulator equals $c \cdot [ER(\sigma_R, \sigma_R) - ER(\sigma_U, \sigma_U)] - k(\sigma_R)$, where $ER(\sigma_R, \sigma_R)$ is the expected return of the investor when minimum disclosure precision σ_R is enforced and $k(\sigma_R)$ is the cost of introducing and enforcing the new regulation. We assume that the welfare function is increasing in σ_R so that $\sigma_R = 1$ is optimal, that is, the regulator will threaten the firms with full disclosure. For ease of exposition, denote by $k > 0$ the cost of full disclosure regulation.

□ **Credible threat of regulation.** The first step in this analysis is the credibility of the threat of regulation. Threatening with disclosure regulation is credible only if the benefit of imposing regulation exceeds the cost k. Otherwise, the investor would not benefit from disclosure regulation, as we assume that they eventually pay the cost of regulation k.

Given σ_U, the disclosure level that arises in equilibrium in an unregulated setting, the investor's benefit of disclosure regulation amounts to the capital invested (c) times the increase in expected return due to moving from the unregulated to the regulated setting, that is, $c(ER(1,1) - ER(\sigma_U, \sigma_U))$. Then, the threat of disclosure regulation is credible if and only if the cost of regulation is less than the benefit of regulation, that is, $k < c\overline{\gamma}(p, \sigma_U)$ where

$$\overline{\gamma}(p, \sigma_U) = ER(1,1) - ER(\sigma_U, \sigma_U). \tag{10}$$

Focusing on regulation cost per unit of investment k/c, we obtain that the threat of regulation is credible if and only if $k/c < \overline{\gamma}(p, \sigma_U)$.

□ **Definition of a regulation deterring disclosure equilibrium.** A regulation deterring disclosure equilibrium arises when the equilibrium disclosure policy choices of the firms are such that the regulator does not impose full disclosure (i.e., $\sigma_R = 1$). One can interpret regulation deterring equilibria as cases where self-regulation works and is forthcoming. In these cases, self-regulation is a nonbinding agreement between the two firms on their disclosure policies. That the agreement is nonbinding reflects the fact that in practice, self-regulated disclosures in the absence of a self-regulatory organization are not actively enforced.

A regulation deterring disclosure equilibrium $(\hat{\sigma}_i, \hat{\sigma}_j)$ arises if and only if for each firm i, the following conditions are satisfied:

$$(\hat{\sigma}_i, \hat{\sigma}_j) \neq (1,1), \tag{11}$$

$$k/c \geq ER(1,1) - ER(\hat{\sigma}_i, \hat{\sigma}_j), \tag{12}$$

$$\begin{gathered} E(U(x_i^*(\hat{\sigma}_i, \hat{\sigma}_j))) \geq E(U(x_i^*(\sigma_i, \hat{\sigma}_j))) \\ \text{for all } \sigma_i \text{ such that } k/c \geq ER(1,1) - ER(\sigma_i, \hat{\sigma}_j), \text{ and} \end{gathered} \tag{13}$$

$$\begin{gathered} E(U(x_i^*(\hat{\sigma}_i, \hat{\sigma}_j))) \geq E(U(x_i^*(1,1))) \\ \text{for all } \sigma_i \text{ such that } k/c < ER(1,1) - ER(\sigma_i, \hat{\sigma}_j). \end{gathered} \tag{14}$$

Condition (11) states that the firms' disclosure policies reveal less information than the regulated, full disclosure policy.[10] Condition (12) states that regulation is deterred, that is, the cost of regulation exceeds the increase in investor welfare of disclosure regulation. Condition (13) states that firms will not deviate to other disclosure policies that still deter regulation, whereas condition (14) states that firms will not deviate to other disclosure policies that do trigger regulation. Note that when the disclosure policy σ_i triggers regulation, the regulator will

[10] When full disclosure is required to deter regulation, firms are indifferent between deterring regulation and regulation. In that case, we assume firms choose the unregulated equilibrium disclosure policy σ_U so that regulation is implemented.

impose disclosure regulation $\sigma_R = 1$ so that firm i' s payoff equals $E(U(x_i^*(1, 1)))$ rather than $E(U(x_i^*(\sigma_i, \hat{\sigma}_j)))$.

In addition, we do not consider whether mixed-strategy deterring equilibrium strategies are possible, as a regulator cannot verify the probability in a mixed strategy, but can only observe the resulting disclosure precision. We thus confine our attention to pure strategies that satisfy conditions (11)–(14).

□ **Regulation deterring disclosure equilibria.** A regulation deterring disclosure equilibrium is called symmetric when both firms choose the same disclosure policy, that is, $\hat{\sigma}_1 = \hat{\sigma}_2$; it is called asymmetric when firms use different disclosure policies, that is, $\hat{\sigma}_1 \neq \hat{\sigma}_2$. Without loss of generality, we denote by firm i the firm that chooses the more informative disclosure policy, that is, $\hat{\sigma}_i > \hat{\sigma}_j$. From the perspective of self-regulation, symmetric disclosure is most consistent with the first attempts to organize self-regulated disclosures in practice. When firms try to self-regulate disclosures, this usually implies that all firms would agree to disclose in line with the same, mutually agreed standards.

Before we present the regulation deterring equilibria, we first introduce some additional notation. Define for $p < \frac{1}{2}$

$$\gamma_H(p, \sigma_U) = \overline{\gamma}(p, \sigma_U) - \tfrac{2p(1-p)r_H}{(1-2p)} \left(\tfrac{1}{2} - \tfrac{1}{1-2u} \left(\sqrt{u(1-u)} - u\right)\right). \tag{15}$$

Furthermore, define

$$\gamma^*(p, \sigma_U) = \overline{\gamma}(p, \sigma_U) - 2r_H p(1-p)(\sigma^* - \sigma_U) \tag{16}$$

$$\underline{\gamma}(p) = (1-p)^2 r_0 \tag{17}$$

$$\sigma(k/c) = \sigma_U + \tfrac{\overline{\gamma}(\sigma_U) - k/c}{2p(1-p)r_H}. \tag{18}$$

The symmetric disclosure equilibria that deter regulation are presented in the following proposition.

Proposition 2. Let $\sigma_U \leq \sigma^*$ be the equilibrium disclosure precision level in the unregulated setting. Then, the following symmetric regulation deterring disclosure equilibria $(\hat{\sigma}_i, \hat{\sigma}_j) = (\sigma, \sigma)$ exist:

A for $p < \frac{1}{2}$: $(\hat{\sigma}_1, \hat{\sigma}_2) = (\sigma, \sigma)$ with $\sigma(k/c) \leq \sigma \leq \min(\sigma^*(p), \sigma_H(p))$ if and only if

$$\max(\gamma^*(p, \sigma_U), \gamma_H(p, \sigma_U)) \leq k/c < \overline{\gamma}(p, \sigma_U).$$

B for $p \geq \frac{1}{2}$: $(\hat{\sigma}_1, \hat{\sigma}_2) = (\sigma, \sigma)$ with $\sigma(k/c) \leq \sigma \leq \sigma^*(p)$ if and only if

$$\gamma^*(p, \sigma_U) \leq k/c < \overline{\gamma}(p, \sigma_U).$$

For a symmetric regulation deterring equilibrium (σ, σ), two conditions have to be met. First, the disclosure policies (σ, σ) should be a Nash equilibrium in the benchmark case with no (threat of) regulation. As in the case without regulation, disclosure policies (σ, σ) with $\sigma > \sigma^*$ can never be an equilibrium, as firms have an incentive to deviate to a marginally more informative equilibrium. Disclosure policies (σ, σ) with $\sigma \leq \sigma^*$ should be an equilibrium in the unregulated setting because firms can deviate to a less informative disclosure policy without triggering regulation. This is because in this case, investor welfare is only determined by the most informative disclosure policy. Therefore, the same upper bounds on σ apply, as in Proposition 1. Second, the disclosure policies should be sufficiently informative to deter regulation. That is, the increase in welfare from full disclosure should be less than or equal to the cost of regulation per unit of investment, that is, $ER(1, 1) - ER(\sigma, \sigma) \geq k/c$. This explains that σ should be at least $\sigma(k/c)$.

Whether the set of policies σ that deter regulation is not empty can be expressed in terms of the cost of regulation. The least informative policy that still deters regulation ($\sigma(k/c)$) should be an equilibrium in the unregulated setting *and* the threat of regulation given the unregulated equilibrium should be credible. The latter yields the upper bound $\overline{\gamma}(p, \sigma_U)$ on k/c (as discussed in the subsection "Credible threat of regulation"). The former implies that the cost of regulation cannot be too low, as that would require the disclosure precision that is required to deter regulation to exceed $\sigma^*(p)$, in which case a symmetric equilibrium is no longer sustainable. For part A, the informativeness of the disclosure policy is bounded from above by $\min(\sigma^*(p), \sigma_H(p))$ (cf. Proposition 1A). The corresponding lower bound on $\sigma(k/c)$ is $\max(\gamma^*(p, \sigma_U), \gamma_H(p, \sigma_U))$. For part B, recall from Proposition 1B that the informativeness of the disclosure policy is bounded from above by $\sigma^*(p)$, which explains the lower bound $\gamma^*(p, \sigma_U)$ on the cost of regulation.

Regulation may also be deterred when firms apply different disclosure precisions. The asymmetric regulation deterring disclosure equilibria are presented in Proposition 3.

Proposition 3. Let $\sigma_U \leq \sigma^*$ be the equilibrium disclosure precision level in the unregulated setting. Then, the following asymmetric regulation deterring disclosure equilibria $(\hat{\sigma}_i, \hat{\sigma}_j)$ exist:

A for $p < \frac{1}{2}$: $\hat{\sigma}_j < \hat{\sigma}_i = \sigma(k/c)$ if and only if

$$\underline{\gamma}(p) \leq k/c < \max(\gamma_H(p, \sigma_U), \gamma^*(p, \sigma_U));$$

B for $p \geq \frac{1}{2}$: $\hat{\sigma}_j \leq \sigma^*(p) < \hat{\sigma}_i = 1$ if and only if

$$\underline{\gamma}(p) \leq k/c < \gamma^*(p, \sigma_U)$$
$$\text{and } p \leq p_{FD}(u).$$

It can be seen immediately from the conditions on k/c that the symmetric and asymmetric regulation deterring equilibria are mutually exclusive. The asymmetric equilibria result for lower values of k/c. Observe that in an asymmetric regulation deterring equilibrium, the payoffs and expected utilities differ across the two firms. Firm i receives all of the investor's capital when she generates the good report and she receives no capital when she generates the bad report; in that case, firm j receives all of the investor's capital.[11] Hence, the payoffs and expected utilities of the two firms are determined by the likelihood that firm i generates the good report. Therefore, the more informative disclosure policy yields higher expected utility than the less informative disclosure policy if and only if $p > \frac{1}{2}$.[12]

When the symmetric pair of disclosure policies $(\sigma(k/c), \sigma(k/c))$ that would deter regulation is not sustainable in equilibrium because firms benefit from deviating to a less informative disclosure policy, an asymmetric regulation deterring equilibrium may exist. To deter regulation, at least one firm (i.e., firm i) must disclose with precision level $\sigma(k/c)$ or higher.

When $p < \frac{1}{2}$, firm i will choose precision level $\sigma(k/c)$, as this maximizes the likelihood of disclosing the good report conditional on deterring the regulation. Firm j discloses with low precision, so as to acquire all of the investor's capital when firm i discloses the bad report. Because $p < \frac{1}{2}$ implies that both firms are more likely to disclose a bad report than a good report, there is no benefit for firm j to disclose more precisely than firm i, that is, a race to the top does not arise.

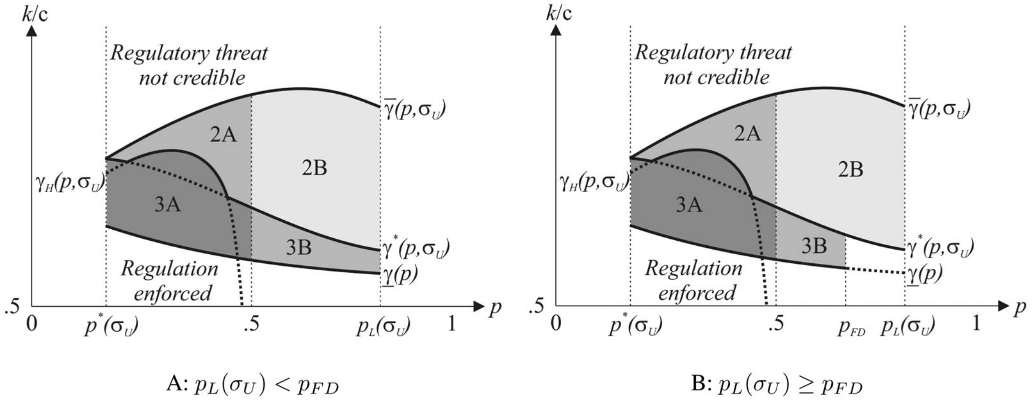
When $\frac{1}{2} < p \leq p_{FD}(u)$, firm i will choose full disclosure, as this maximizes the likelihood of disclosing the good report. Firm j still discloses with low precision, so as to acquire all capital when firm i discloses the bad report. The reason that a race to the top does not arise is because $p \leq p_{FD}(u)$. The likelihood of disclosing the good report is not high enough so that the benefits

[11] When firm j would choose precision $\sigma_j > \sigma^*(p)$, it would not always receive the investor's capital, but this never occurs in equilibrium, as then firm j would be better off choosing a disclosure policy $\sigma_j \leq \sigma^*(p)$ or $\sigma_j \geq \sigma_i$.

[12] Therefore, if one of the two firms is a first mover or has a credible threat to choose a disclosure strategy, this firm would choose the low disclosure precision when $p < \frac{1}{2}$ but the high disclosure precision when $p > \frac{1}{2}$ (i.e., the disclosure policy with the higher likelihood of generating the good report).

FIGURE 3

EXISTENCE OF REGULATION DETERRING DISCLOSURE EQUILIBRIA AS A FUNCTION OF THE SUCCESS PROBABILITY p AND PER UNIT REGULATORY COST k/c. THE LABELS OF THE DIFFERENT AREAS IN THE GRAPH REFER TO THE PROPOSITIONS THAT DESCRIBE THE SYMMETRIC AND ASYMMETRIC REGULATION DETERRING EQUILIBRIA



of full disclosure for firm j do not outweigh the costs: the likelihood that full disclosure by firm j results in disclosing the bad report is still considerable, in which case, firm j would receive zero investment.

To explain the boundaries on k/c in Proposition 3A, recall that a symmetric equilibrium is not sustainable for $p < \frac{1}{2}$ when $\sigma(k/c) > \sigma^*(p)$, or when $\sigma(k/c) > \sigma_H(p)$ (Proposition 1A and Figure 2). The lower bound $\sigma(k/c) \geq \sigma_H(p)$ induces the upper bound $k/c \leq \gamma_H(p, u)$ on the cost of regulation, and $k/c \leq \gamma^*(p, u)$ arises from $\sigma(k/c) \geq \sigma^*(p)$. Observe that because an asymmetric equilibrium requires $\sigma(k/c) > \sigma^*(p)$ or $\sigma(k/c) > \sigma_H(p)$, it follows that $k/c < \max(\gamma_H(p, \sigma_U), \gamma^*(p, \sigma_U))$. Further, observe that this upper bound on the cost of regulation is identical to the lower bound in Proposition 2A for a symmetric deterring equilibrium to exist.

For Proposition 3B, the bounds on the cost of regulation follow from $\sigma^*(p) < \sigma(k/c) \leq 1$.

Note that when $p \geq \frac{1}{2}$ and $\sigma(k/c) < 1$, the equilibrium disclosure level for the more informative firm i (cf. Proposition 3B) is higher than necessary to deter regulation. As a consequence, investor welfare when deterring regulation is higher than investor welfare under regulation. Indeed, for the equilibrium of Proposition 3B, it holds that $ER(\hat{\sigma}_i, \hat{\sigma}_j) > ER(\sigma(k/c), \hat{\sigma}_j) = ER(1, 1) - k/c$. Hence, when $p \geq \frac{1}{2}$ and $\sigma(k/c) < 1$, investors are better off by merely the threat of regulation than by regulation itself.

Note that also the symmetric regulation deterring equilibria may consist of levels of disclosure that exceed the minimum level required to deter regulation. These equilibrium strategies are, however, also equilibrium strategies in the unregulated setting. Dependent on the equilibrium selection, it is therefore likely that either the more informative disclosure already resulted, making deterring regulation by symmetric disclosures not feasible, or — in case no disclosure resulted in the unregulated setting — that firms under regulatory threat will also choose the minimum level of disclosure to deter regulation, in which case investors are indifferent between regulation and regulatory threat. We elaborate on the equilibrium selection under payoff and risk dominance in the next section.

6. Discussion

■ Figure 3 shows the existence of regulation deterring disclosure equilibria as a function of the success probability p and regulatory cost per unit investment k/c, given a level σ_U (which is indicated in Figure 2).[13] The labels of the different areas in the graph refer to the propositions that describe the symmetric and asymmetric regulation deterring disclosure equilibria. Recall that Proposition 2 concerns the symmetric equilibria and that Proposition 3 concerns the asymmetric equilibria. Panels A and B match the unregulated equilibria in Panels A and B of Figure 2. In Panel A, $p_{FD} > p_L(\sigma_U)$, making the condition $p \leq p_{FD}$ from Proposition 3B irrelevant, whereas in Panel B, $p_{FD} < p_L(\sigma_U)$, which limits the values of p for which an asymmetric equilibrium cf. Proposition 3B exists. Note that Figure 3 indicates the existence of equilibria as a function of p and k/c so that, contrary to Figure 2, the possible equilibrium disclosure precision levels σ are not indicated.

For a given value of p, Figure 3 shows that symmetric regulation deterring equilibria exist for relatively high values of the cost of regulation per unit of investment k/c and asymmetric regulation deterring equilibria exist for intermediate values of k/c. The explanation for this is that the lower the cost of regulation, the more informative the disclosure policies should be in order to deter regulation. For high values of k/c, disclosure precision can remain below the threshold $\sigma^*(p)$ so that symmetric disclosure equilibria are feasible. For intermediate values of k/c, one firm has to use a disclosure precision above the threshold $\sigma^*(p)$. Also, for even lower values of k/c, both firms would have to use disclosure precision levels above the threshold $\sigma^*(p)$. This would result in full disclosure by both firms as the only option which is not considered a regulation deterring equilibrium.

Observe that the lower bound $\underline{\gamma}(p)$ is decreasing in the success probability p. This indicates that implementation of regulation will be observed especially when the success probability is low, that is, in high-risk markets or economic bad times. This is precisely when threatening with regulation yields the same investor welfare as regulation itself. Recall that for $p \geq \frac{1}{2}$, the investor is (weakly) better off when the regulator threatens with regulation than when the regulator imposes regulation. This implies that threatening with regulation is more efficient than regulation in low-risk markets or economic good times.

Regarding the dependence on σ_U, note that for higher values of σ_U, that is, when firms already disclose with higher precision, some of the symmetric deterring equilibria disappear, as for these values, the threat of regulation is not credible anymore. Also, the region of values of p for which deterrence of regulation may be relevant shifts to the right when σ_U increases.

□ **Equilibrium selection.** Proposition 1 shows that in the unregulated setting multiple equilibria exist. Thus far, we have ignored equilibrium selection issues and assumed that any of the equilibria can arise; the regulation deterring equilibria are determined for any possible unregulated equilibrium. In this subsection, we shortly discuss two equilibrium refinements: payoff dominance and risk dominance (cf. Harsanyi and Selten, 1988).

When considering the possible equilibria from Proposition 1A (i.e., $p < \frac{1}{2}$), for any two equilibria with respective disclosure policy $\sigma_1 > \sigma_2$, the equilibrium with the more informative disclosure policy σ_1 is payoff dominant over disclosure policy σ_2, whereas the less informative σ_2 is risk dominant over disclosure policy σ_1.[14] This implies that under payoff dominance $\sigma_U = \min(\sigma^*(p), \sigma_H(p))$ arises, whereas under risk dominance $\sigma_U = \frac{1}{2}$ arises. For the possible deterrence of regulation, this implies that under payoff dominance for $p < \frac{1}{2}$, only asymmetric deterring equilibria exist: $\overline{\gamma}(p, \sigma_U)$ coincides with $\max(\gamma_H(p, \sigma_U), \gamma^*(p, \sigma_U))$. For risk dominance, both symmetric and asymmetric equilibria exist.

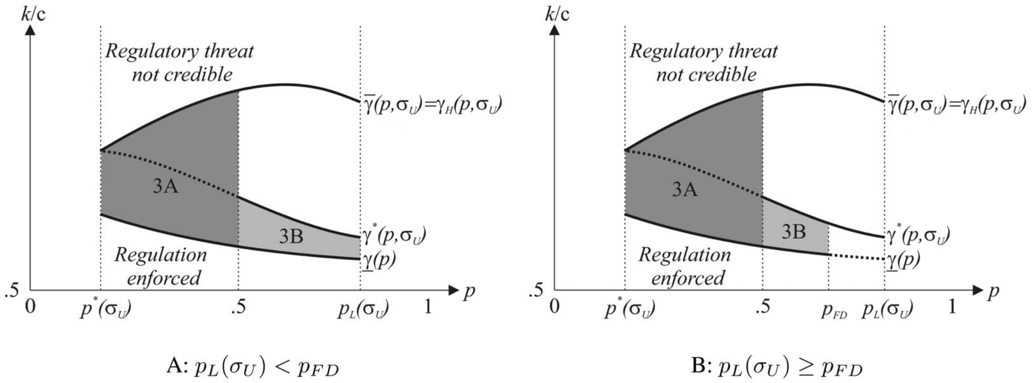
For $p \geq \frac{1}{2}$, the strategy $\sigma_U = \sigma^*(p)$ is both payoff dominant and risk dominant for $p < \min(p_{FD}, p_L(\sigma^*))$. Again, this implies that in these cases, symmetric deterring equilibria

[13] Figure 3 suggests that only the cost of regulation per unit investment k/c matters and not the values of k and c separately. This need not be completely true. The values $p_{FD}(u)$ depend on u, which in turn may depend on c. For expositional purposes, we choose to ignore these dependencies. Notice that the relation between $p_{FD}(u)$ and c is not clear, as $p_{FD}(u)$ is increasing in u and u may depend on c.

[14] Details on the proofs on payoff and risk dominance are available from the authors upon request.

FIGURE 4

EXISTENCE OF REGULATION DETERRING DISCLOSURE EQUILIBRIA AS A FUNCTION OF THE SUCCESS PROBABILITY p AND PER UNIT REGULATORY COST k/c WHEN $u = \frac{1}{2}$ (I.E., RISK NEUTRALITY). THE LABELS OF THE DIFFERENT AREAS IN THE GRAPH REFER TO THE PROPOSITIONS THAT DESCRIBE THE SYMMETRIC AND ASYMMETRIC REGULATION DETERRING EQUILIBRIA



do not exist, as the symmetric equilibrium that yields the highest investor welfare already results in the unregulated case. Therefore, regulation can only be deterred by an asymmetric equilibrium. A difference between payoff and risk dominance occurs in the resulting unregulated equilibrium when $p_{FD} < p_L(\sigma^*)$. Then, for $p_{FD} < p < p_L(\sigma^*)$, full disclosure is risk dominant so that regulation deterrence is not relevant, whereas $\sigma_U = \sigma^*(p)$ is still payoff dominant so that regulation may be welfare-enhancing and firms may deter regulation by an asymmetric equilibrium cf. Proposition 3B.

Summarizing, when considering payoff or risk dominance as the selection criterion for the unregulated equilibrium, the firms may disclose with very low precision for high-risk investments (i.e., $p < \frac{1}{2}$) so that both symmetric and asymmetric regulation deterring equilibria exist. For low-risk investments (i.e., $p \geq \frac{1}{2}$), the firms already choose a relatively informative disclosure policy in the absence of (threat of) regulation, so that regulation can only be deterred by an asymmetric equilibrium.

□ **The effect of managerial risk aversion.** Figure 4 summarizes the regulation deterring equilibria for risk-neutral managers. Recall that with risk-neutral managers, there are no multiple equilibria in the unregulated case. A level of disclosure lower than $\sigma^*(p)$, namely, nondisclosure, only results for $p < \frac{1}{2}$. In this case, the symmetric regulation deterring equilibria no longer exist. The explanation for this is that investor welfare is only determined by the most informative disclosure policy. Hence, disclosure policies $(\hat{\sigma}_i, \hat{\sigma}_j) = (\sigma, \sigma)$ with $\sigma \leq \sigma^*(p)$ cannot constitute a regulation deterring equilibrium, as a firm can deviate to a nondisclosure policy without triggering regulation; and nondisclosure increases the firm's expected utility when the managers are risk neutral, as nondisclosure maximizes the likelihood of generating the good report.

Observe that managerial risk aversion only affects the threshold values $\gamma_H(p, \sigma_U)$, p_{FD}, and $p_L(\sigma_U)$; the threshold values $\bar{\gamma}(p, \sigma_U)$, $\gamma^*(p, \sigma_U)$, and $\underline{\gamma}(p)$ are independent of managerial risk aversion. In particular, it holds that $\lim_{u \to \frac{1}{2}} \gamma_H(p, u) = \bar{\gamma}(p, \sigma_U)$, which implies that as managerial risk aversion decreases, the asymmetric regulation deterring equilibria in Proposition 3 A substitute for the symmetric regulation deterring equilibria. Note that this does not affect investor welfare, as the most informative disclosure, policy does not change; it still equals $\sigma(k/c)$. However, the asymmetric regulation deterring equilibrium does create a coordination problem among the two firms.

□ **Disclosure costs.** The model assumes that more precise disclosure comes at no additional cost. When we assume that the cost of disclosure policy σ_i is increasing in the precision σ_i, our results do not qualitatively change. The reason for this is that only deviations to a slightly more informative disclosure policy matter. This will not materially affect the cost of disclosure, but it does result in material benefits, as the firm no longer needs to share the investors' capital when it discloses a good report. The trade-offs are therefore not significantly affected by disclosure costs. The conditions on p in Proposition 1 will change to take account of the difference in disclosure costs, that is, the expressions for $p_L(\sigma, u)$, $p_H(\sigma, u)$, and $p_{FD}(u)$ will change. The resulting unregulated equilibrium is more likely to be less informative than (σ^*, σ^*) when this disclosure policy is too costly. Summarizing, introducing disclosure costs will not make the equilibrium disclosures more precise. Hence, the demand for regulation remains.

In the setting with regulatory threat, disclosure cost does not qualitatively affect Proposition 2 and Proposition 3A. In particular, observe that the equilibrium disclosure precision policy $\sigma(k/c)$ is not affected by the disclosure cost. Even if the cost of disclosure policy $\sigma(k/c)$ is rather high, deviating to a less precise disclosure policy is not an option as this will trigger regulation, in which case, the firm has to use a disclosure policy that is more precise and thus more costly than $\sigma(k/c)$. A disclosure cost does affect Proposition 3B in the sense that now a disclosure policy $\hat{\sigma}_i \in [\sigma(k), 1)$ may be optimal. This arises when full disclosure is too costly.

□ **Competition for capital and self-regulated disclosures.** Competition between the firms crucially affects disclosure behavior to deter regulation. First, it is seen immediately that in the absence of competition and in the absence of regulation or any threat thereof, the firm would prefer to never disclose precise information, as in that case, all capital will be invested in the firm, as it is preferred to the alternative investment opportunity without additional information. When competition between firms is incorporated, this is not necessarily true and firms may prefer full disclosure (when $p \geq p_{FD}$). This is in line with recent empirical research in Burks, Cuny, Gerakos, and Granja (2018) showing that competition may create incentives to increase disclosure.

When there is a threat of regulation in a single-firm setting, the optimal behavior is also intuitively clear. If $p < \frac{1}{2}$, the firm maximizes the probability of a good report by minimizing its disclosure precision. Therefore, the firm will choose the lowest disclosure level so that the regulator is indifferent between introducing and not introducing regulation. When $p \geq \frac{1}{2}$, the firm will choose a precision $\sigma \leq \sigma^*$ when this deters regulation so as to attract all the investor's capital, and the firm will choose full disclosure when $\sigma = \sigma^*$ is not sufficient to deter regulation. Then, full disclosure maximizes the probability of a good report. Therefore, it is unlikely that deterring regulation fails in a single-firm setting. However, in the two-firm setting, this no longer needs to be the case, as a free-riding problem may arise. An improved disclosure by only one firm increases investor welfare and may make the regulator indifferent. In high-risk markets (low p), the nondisclosing firm is better off than the disclosing firm, which gives rise to serious coordination issues.

□ **Self-regulation and policy implications.** Regulation deterring disclosure strategies can also be interpreted as self-regulation by the sector. The above analysis yields implications for policy makers, regulators, and supervisory bodies as well as for market participants with respect to self-regulation.

First of all, for $p \geq \frac{1}{2}$, our results show that threatening with regulation may result in higher investor welfare than actually imposing and enforcing disclosure regulation. The mere threat of new disclosure regulation may be sufficient to achieve the desired disclosure levels without bearing any cost of disclosure regulation.

Second, when market participants try to set up self-regulation, they generally try to come up with a set of minimum disclosure requirements to which all participants should comply. Regulators or supervisory bodies sometimes try to facilitate the self-regulatory process. In all these cases, large effort is spent to making sure every firm is and remains "on board." Our results indicate that it may be possible (especially when cost of regulation is low relative to market size or when managerial risk aversion is low) to make investors just as well off by making an agreement with only a few large market participants.[15] Sometimes it may be unfeasible to make every firm comply. In that case, failure of self-regulation may be due to a coordination problem: which firms will be "on board" and which will not. Especially for investments with relatively low success probabilities, the self-regulated firms will be worse off, making the coordination issue a possible reason why self-regulation will not succeed.

Finally, policy makers frequently first try to make market participants regulate themselves. Our results indicate when it may be interesting to put effort in this process or when it is likely not to succeed so that regulation may be imposed more quickly.

□ **Implications for empirically observed disclosure behavior.** The results of this study indicate that for understanding voluntary disclosure, we need to take into account not only implemented regulation but also any existing threat of regulation. Consider, for example, the ambiguous evidence on the effectiveness and efficiency of the Securities Acts of 1933 and 1934 and the discussion about whether government intervention was right. One of the arguments made against the 1933–1934 acts is that the existence of voluntary disclosure prior to 1933–1934 would be evidence that existing mechanisms were sufficient to ensure production of a sufficient level of disclosure to investors. Merino and Neimark (1982) argue that this voluntary disclosure was not that "voluntary," but "it does appear to have played a role in deterring enactment of a federal incorporation law". They posit that "one motive for 'voluntary' disclosure was to preclude more draconian government regulation." Our model shows that "voluntary" disclosure can do exactly this. Our model even suggests that it may well be that regulation is deterred by disclosure up to a level that investors are overall just as good off as with regulation. With respect to the 1933–1934 acts, it may thus be argued that political pressure had shifted the balance so that regulation was preferred to self-regulation, although the regulator could have been indifferent when considering investor welfare. Indeed, scandals often lead to regulation due to public debate (see, e.g., Ball, 2009). If indeed deterrence of regulation was driving voluntary disclosures prior to 1933–1934, and the regulator was indifferent from an investor welfare perspective, this could explain that much empirical research does not find a significant change in mean rate of return in the before and after period of these acts.[16] When accounting for costs of regulation that are likely to be paid eventually by the investors, investors would indeed be indifferent. Apart from political pressure, another reason to have those acts in place that is in line with no change in investor welfare is suggested by Merino and Neimark (1982): "The securities acts were not so much acts . . . , whose primary purpose was to inform investors, but attempts to maintain a status quo that has perpetuated the social accountability of large corporations." Similarly, the ongoing debate on internal control regulation may have led to "voluntary" self-regulation prior to the Sarbanes-Oxley Act (SOX), which could help in explaining the contradictory evidence on whether investors are better off after SOX (see, e.g., Engel, Hayes, and Wang, 2007; Leuz, 2007; Zhang, 2007; Li, Pincus, and Rego, 2008).

Our results imply that observed voluntary disclosure may be due to the threat of regulation. So, instead of looking for direct economic benefits as explanations for observed disclosure behavior, one may find the explanation in the political environment, that is, the observed disclosure behavior does not yield direct economic benefits but only serves to deter more stringent disclosure regulation. Instead of finding benefits like signalling, cross-sectional differences in disclosure

[15] For example, for the case of self-regulated disclosure requirements for real estate investment funds in the Netherlands, the regulator tried to facilitate the self-regulatory process by requiring a minimum participation rate of 75%. This self-regulatory process lasted for five years without any satisfying end result. Some funds appeared to be more willing than others, but no overall agreement could be reached.

[16] For example, Stigler (1964), Benston (1969, 1973), and Deakin (1976) find no evidence of significant changes in securities prices and investor behavior before and after the acts. On the other hand, some evidence of changed investor behavior is found by Ingram and Chewning (1983) when separating positive and negative return securities.

behavior may just be a sustainable asymmetric regulation deterring equilibrium. Such equilibria are more likely to result in cases where the market size is relatively high compared to regulation cost. In contrast, regulation deterring equilibria where firms use similar partial disclosure policies are more likely to result when the market size is relatively low compared to the cost of regulation.

Finally, the results may provide an additional explanation for cross-country differences in voluntary disclosure behavior. When the possible cost of regulation is relatively high (e.g., less-developed countries with relatively inefficient or weak legal systems), disclosures have to be less informative to deter regulation. This could be an additional reason for different levels of disclosure by multinationals in different countries.

7. Conclusion

■ In this article, we derive sustainable voluntary disclosure strategies that result due to a threat of regulation. We consider a model where two firms offer an investment opportunity and an investor is investing a certain amount of money in either of both firms or an alternative investment opportunity. Because of investor response uncertainty, relatively uninformative disclosures may result as optimal Nash equilibrium strategies in an unregulated setting. We show that a credible threat to regulate disclosure may increase voluntary disclosure by one or both firms. Surprisingly, regulatory threat can result in higher investor welfare than actually enacting regulation.

The results yield insight in why self-regulation is forthcoming in some markets but not in others, and when regulation is more likely to be implemented. With respect to self-regulation, regulators often try to mediate in finding a satisfying minimum level of disclosure. However, investors may sometimes be just as well off with a solution where only a (significant) group of firms discloses sufficient information and the others do not. This may change the focus in the process of facilitating and mediating self-regulation. It does, however, also create a coordination problem, as firms participating in the self-regulatory disclosure scheme may be worse off than the nonparticipating firms. Lack of coordination then results in failure of the self-regulatory process. Apart from regulation to be implemented because of lack of coordination, it is also possible that firms need to be too forthcoming to avert regulation. Both reasons for regulation are more likely to happen in high-risk markets or periods.

Apart from these policy implications, our results provide an alternative explanation for observed "voluntary" disclosure that is of interest to empirical disclosure research. Our results show that one needs to take into account potential regulations that are unobserved when trying to explain voluntary disclosure behavior, as voluntary disclosure policies may not always be due to direct economic benefits but may also be forthcoming to deter additional regulation. Furthermore, increased regulation deterring disclosures prior to the introduction of new acts may provide an explanation for the weak empirical evidence regarding social benefits of new disclosure regulations, once these have been enacted.

Finally, from a broader perspective, our results related to possible failures of self-regulation due to coordination problems may be relevant for other regulatory settings than disclosure. It may be interesting to study for other kinds of market failures whether regulation can be forestalled by asymmetric preemptive actions and under what conditions such equilibria are sustainable.

Appendix A

This appendix presents the mathematical proofs of the propositions presented in the main text.

Proof of Proposition 1A. Take $p \in [r_0/r_H, \frac{1}{2})$ and let $\hat{\sigma}_i = \hat{\sigma}_j = \sigma$.

Case 1. $\sigma \leq \sigma^*(p)$.

The expected utility of manager i equals (cf. case I in Table 2)

$$\tfrac{1}{U(c)} \cdot E\left(U(\tilde{x}_i(\hat{\sigma}_i, \hat{\sigma}_j))\right) = 1 - \pi + \pi^2 - u(1 - 2\pi + 2\pi^2),$$

where π is shorthand notation for $\pi(\sigma) = p\sigma + (1-p)(1-\sigma)$. In equilibrium, manager i should not benefit from choosing a disclosure policy $\sigma_i \neq \sigma$. We therefore consider when deviating to a lower or higher disclosure level is not optimal. □

We start with considering deviations to a lower disclosure level. When $\sigma_i < \sigma$, the expected utility of manager i equals (cf. case III in Table 2)

$$\tfrac{1}{U(c)} \cdot E\left(U(\tilde{x}_i(\sigma_i, \hat{\sigma}_j))\right) = 1 - \pi.$$

Firm i in this case only receives capital in case firm j discloses a bad report. In equilibrium, it should hold that $(1 - \pi + \pi^2) - u(1 - 2\pi + 2\pi^2) \geq 1 - \pi$. Rearranging terms yields $\pi^2(1-2u) + 2\pi u - u \geq 0$, which is equivalent to

$$\pi \leq -\tfrac{u}{1-2u} - \tfrac{1}{1-2u}\sqrt{u(1-u)} \text{ or } \pi \geq -\tfrac{u}{1-2u} + \tfrac{1}{1-2u}\sqrt{u(1-u)}.$$

Because $-\frac{u}{1-2u} - \frac{1}{1-2u}\sqrt{u(1-u)} \leq 0$, only the latter inequality is relevant. Substituting $\pi = 1 - \sigma + p(2\sigma - 1)$ and rearranging terms yields $p \geq p_H(\sigma)$, or equivalently, $\sigma \leq \sigma_H(p)$.

Next, consider deviations to a higher disclosure level. When $\sigma_i > \sigma$, the expected utility of manager i equals (cf. case III in Table 2)

$$\tfrac{1}{U(c)} \cdot E\left(U(\tilde{x}_i(\sigma_i, \hat{\sigma}_j))\right) = \pi(\sigma_i).$$

Because $p < \frac{1}{2}$, it holds that for $\sigma_i > \frac{1}{2}$, $\pi(\sigma_i) < \frac{1}{2} < 1 - \pi(\sigma_i)$, so that deviations to a lower disclosure level always dominate deviations to a higher level.

To conclude case 1, $\hat{\sigma}_i = \hat{\sigma}_j = \sigma$ satisfies the equilibrium conditions if and only if $\sigma \leq \min(\sigma^*(p), \sigma_H(p))$.

Case 2. $\sigma > \sigma^*(p)$.

The expected utility of manager i equals (cf. case II in Table 2)

$$\tfrac{1}{U(c)} \cdot E\left(U\left(\tilde{x}_i(\hat{\sigma}_i, \hat{\sigma}_j)\right)\right) = \pi(1 - \pi u).$$

We show that manager i is better off deviating to a less informative disclosure level $\sigma_i < \sigma^*(p)$. In that case, the expected utility of manager i equals (cf. case III in Table 2)

$$\tfrac{1}{U(c)} \cdot E\left(U\left(\tilde{x}_i(\hat{\sigma}_i, \hat{\sigma}_j)\right)\right) = 1 - \pi.$$

The inequality $1 - \pi > \pi(1 - \pi u)$ is equivalent to $(\pi - \frac{1}{2})^2 > \frac{1-u}{u^2}$. This implies $\pi > \frac{1}{u}(1 + \sqrt{1-u})$ or $\pi < \frac{1}{u}(1 - \sqrt{1-u})$. Because $\frac{1}{u}(1 - \sqrt{1-u}) \geq \frac{1}{2} > p$, the latter inequality is satisfied so that $\hat{\sigma}_i = \hat{\sigma}_j = \sigma$ cannot be an equilibrium for $\sigma > \sigma^*(p)$.

Proof of Proposition 1B. Take $p \geq \frac{1}{2}$ and let $\hat{\sigma}_i = \hat{\sigma}_j = \sigma$.

Case 1. $\sigma \leq \sigma^*(p)$.

The expected utility of manager i equals (cf. case I in Table 2)

$$\tfrac{1}{U(c)} \cdot E\left(U(\tilde{x}_i(\hat{\sigma}_i, \hat{\sigma}_j))\right) = 1 - \pi + \pi^2 - u(1 - 2\pi + 2\pi^2).$$

In equilibrium, manager i should not benefit from choosing a disclosure policy $\sigma_i \neq \sigma$. □

We start with considering deviations to a *lower* disclosure level. This analysis is similar to part A and yields the condition $p \geq p_H(\sigma)$. It is straightforward to show that $p_H(\sigma) \leq \frac{1}{2}$. Hence, $p \geq \frac{1}{2}$ implies that the condition $p \geq \sigma_H(p)$ is always met.

Next, consider deviations to a *higher* disclosure level. When $\sigma_i > \sigma$, the expected utility of manager i equals (cf. case III in Table 2)

$$\tfrac{1}{U(c)} \cdot E\left(U(\tilde{x}_i(\sigma_i, \hat{\sigma}_j))\right) = \pi(\sigma_i),$$

so that the equilibrium condition requires $(1 - \pi + \pi^2) - u(1 - 2\pi + 2\pi^2) \geq \pi(\sigma_i)$ for all $\sigma_i > \sigma$, that is, $(1 - \pi + \pi^2) - u(1 - 2\pi + 2\pi^2) \geq \max_{\sigma_i > \sigma} \pi(\sigma_i)$. Because $\pi(\sigma_i) = 1 - p + \sigma_i(2p - 1)$ and $p \geq \frac{1}{2}$, it follows that $\max_{\sigma_i > \sigma} \pi(\sigma_i) = p$ (i.e., $\sigma_i = 1$). The equilibrium condition then reduces to

$$(1 - \pi + \pi^2) - u(1 - 2\pi + 2\pi^2) \geq p,$$

which is equivalent to

$$(1 - 2u)\left(\pi - \tfrac{1}{2}\right)^2 \geq \tfrac{1}{2}(2p - 1) - \tfrac{1}{4}(1 - 2u).$$

The right-hand side of this inequality is nonpositive if and only if $p \leq \frac{3}{4} - \frac{1}{2}u$. Hence, deviating to a more informative disclosure policy does not pay when $p \leq \frac{3}{4} - \frac{1}{2}u$. When $p > \frac{3}{4} - \frac{1}{2}u$, it should hold that[17]:

$$\pi \leq \frac{1}{2} - \frac{1}{2}\sqrt{2\frac{2p-1}{1-2u} - 1} \text{ or } \pi \geq \frac{1}{2} + \frac{1}{2}\sqrt{2\frac{2p-1}{1-2u} - 1}.$$

Because $\frac{1}{2} - \frac{1}{2}\sqrt{2\frac{2p-1}{1-2u} - 1} \leq \frac{1}{2}$ and $p > \frac{1}{2}$ and $\sigma_i > \sigma \geq \frac{1}{2}$ imply $\pi > \frac{1}{2}$, the former inequality cannot be satisfied. Hence, in equilibrium it must be that $\pi \geq \frac{1}{2} + \frac{1}{2}\sqrt{2\frac{2p-1}{1-2u} - 1}$. Substituting $\pi = (1-\sigma) + p(2\sigma - 1)$ and rewriting the inequality then yields $p \leq p_L(\sigma)$, or equivalently, $\sigma \geq \sigma_L(p)$.

Observe that $\frac{3}{4} - \frac{1}{2}u \leq p_L(\sigma)$. To see this, the inequality $\frac{3}{4} - \frac{1}{2}u \leq p_L(\sigma)$ is equivalent to

$$\frac{1}{2}(1-2u) \leq \frac{1}{(1-2u)(1-2\sigma)^2}\left(1 - \sqrt{1-(1-2u)^2(1-2\sigma)^2}\right).$$

Substituting $z = (1-2u)^2(1-2\sigma)^2$, this inequality reduces to $\frac{1}{2}z \leq 1 - \sqrt{(1-z)}$. Rewriting this inequality yields $\frac{1}{4}z^2 \geq 0$, which holds true for all z.

Summarizing case I, an equilibrium exists if and only if $\max(\frac{1}{2}, \sigma_L(p)) \leq \sigma \leq \sigma^*(p)$.

Case 2. $\sigma > \sigma^*(p)$.

The expected utility of manager i equals (cf. case II in Table 2)

$$\frac{1}{U(c)} \cdot E\left(U\left(\tilde{x}_i(\hat{\sigma}_i, \hat{\sigma}_j)\right)\right) = \pi(1 - \pi u).$$

We show that manager i is better off deviating to full disclosure $\sigma_i = 1$. In that case, the expected utility of manager i equals (cf. case IV in Table 2)

$$\frac{1}{U(c)} \cdot E\left(U\left(\tilde{x}_i(\sigma_i, \hat{\sigma}_j)\right)\right) = \pi(1) = p,$$

which is clearly greater than $\pi(1 - \pi u)$ as $\pi \leq p$ for $p \geq \frac{1}{2}$.

To complete the proof, we need to show that $\sigma_L(p) \leq \sigma^*(p)$ if and only if $p \leq \overline{p}$. Observe that $\sigma_L(\frac{3}{4} - \frac{1}{2}u) = \frac{1}{2} < \sigma^*(\frac{3}{4} - \frac{1}{2}u)$ and $\sigma_L(p) = 1 > \sigma^*(p)$ for $p = \frac{1}{2} + \frac{1}{2(1-2u)}(1 - \sqrt{2u})$. Hence, there exists $\overline{p} > \frac{1}{2}$ such that $\sigma_L(\overline{p}) = \sigma^*(\overline{p})$. Furthermore, numerical analysis confirms that this $\overline{p}$ is unique. Using that $p_L(\sigma)$ is the inverse of $\sigma_L(p)$, the equality $\sigma_L(\overline{p}) \leq \sigma^*(\overline{p})$ is equivalent to $\overline{p} = p_L(\sigma^*(\overline{p}))$.

Proof of Proposition 1C. When $\hat{\sigma}_i = \hat{\sigma}_j = 1$, it holds that $\pi(\hat{\sigma}_i) = p$ so that the expected utility of manager i equals (cf. case II in Table 2)

$$\frac{1}{U(c)} \cdot E\left(U(\tilde{x}_i(\hat{\sigma}_i, \hat{\sigma}_j))\right) = p\,(1 - pu).$$

For this to be an equilibrium, manager i should not benefit from choosing a disclosure policy $\sigma_i < 1$.

First, when $1 > \sigma_i > \sigma^*$, the expected utility of manager i equals (cf. case IV in Table 2)

$$\frac{1}{U(c)} \cdot E\left(U(\tilde{x}_i(\sigma_i, \hat{\sigma}_j))\right) = \pi(\sigma_i)(1-p) \leq p(1-p).$$

□

Because $u \in [0, \frac{1}{2}]$, this is less than $E(U(\tilde{x}_i(\hat{\sigma}_i, \hat{\sigma}_j)))$, so that manager i does not benefit from choosing a less informative disclosure policy $\sigma_i > \sigma^*$.

Second, when $\sigma_i \leq \sigma^*$, the expected utility of manager i equals (cf. case III in Table 2)

$$\frac{1}{U(c)} \cdot E\left(u(\tilde{x}_i(\sigma_i, \hat{\sigma}_j))\right) = 1 - p.$$

For $(\hat{\sigma}, \hat{\sigma})$ to be an equilibrium, it should hold that $p(1 - pu) \geq 1 - p$, which is equivalent to

$$p \leq \frac{1}{u} + \frac{1}{u}\sqrt{1-u} \text{ or } p \geq \frac{1}{u} - \frac{1}{u}\sqrt{1-u}.$$

The former inequality is always satisfied as $\frac{1}{u} + \frac{1}{u}\sqrt{1-u} \geq 2$. Hence, manager i does not benefit from choosing a less informative disclosure policy $\sigma_i \leq \sigma^*$ if and only if $p \geq \frac{1}{u} - \frac{1}{u}\sqrt{1-u}$, that is, $p \geq p_{FD}$.

Proof of Proposition 1D. Here, we proof the existence of the mixed-strategy equilibrium. Assume managers i and j choose disclosure level $\sigma^*(p)$ with probability $q \in (0, 1)$ and full disclosure with probability $1 - q$. The probability q satisfies

$$q\left(1 - \pi + \pi^2 - u\left(1 - 2\pi + 2\pi^2\right)\right) + (1-q)(1-p) = qp + (1-q)p(1-pu),$$

[17] The following root is not defined for $p < \frac{3}{4} - \frac{1}{2}u$.

where π is shorthand notation for $\pi(\sigma^*(p)) = 1 - p + \sigma^*(p)(2p - 1)$. The left-hand side of the equation is the expected payoff when manager i chooses disclosure policy $\sigma^*(p)$; the right-hand side is the expected payoff when manager i chooses full disclosure. In other words, q is such that manager i is indifferent between $\sigma^*(p)$ and full disclosure. $q \geq 0$ is equivalent to $p \leq p_{FD}$; $q \leq 1$ is equivalent to $p \geq p_L(\sigma^*(p))$, which in turn is equivalent to $p \geq \overline{p}$. □

Next, we show that deviating to $\sigma_i < \sigma^*(p)$ is suboptimal for manager i. The expected utility of σ_i equals

$$\frac{1}{U(c)} \cdot E\left(u(\tilde{x}_i(\sigma_i, \hat{\sigma}_j))\right) = q(1 - \pi) + (1 - q)(1 - p).$$

In equilibrium, it should hold that the expected payoff of $\sigma^*(p)$ is at least as good as σ_i, that is,

$$q\left(1 - \pi + \pi^2 - u\left(1 - 2\pi + 2\pi^2\right)\right) + (1 - q)(1 - p) \geq q(1 - \pi) + (1 - q)(1 - p).$$

This is equivalent to $(1 - 2u)\pi^2 + 2u\pi - u \geq 0$. Rearranging terms yields $p \geq p_H(\sigma^*)$. Observe that this inequality is satisfied as $p \geq p_L(\sigma^*(p)) > \frac{1}{2} > p_H(\sigma^*(p))$.

Finally, we show that deviating to $\sigma_i \in (\sigma^*(p), 1)$ is suboptimal. The expected utility of σ_i equals

$$\tfrac{1}{U(c)} \cdot E\left(u(\tilde{x}_i(\sigma_i, \hat{\sigma}_j))\right) = q\pi(\sigma_i) + (1 - q)\pi(\sigma_i)(1 - p).$$

In equilibrium, it should hold that the expected payoff of $\sigma^*(p)$ is at least as good as full disclosure, that is,

$$qp + (1 - q)p(1 - pu) \geq q\pi(\sigma_i) + (1 - q)\pi(\sigma_i)(1 - p).$$

Rearranging terms yields $p - \pi(\sigma) + (1 - q)p(\pi(\sigma) - pu) \geq 0$. Because $p > p_L(\sigma^*(p)) > \frac{1}{2}$ and $u \in [0, \frac{1}{2}]$, it follows that $p > \pi(\sigma_i)$ and $\pi(\sigma_i) - pu > \pi(\sigma_i) - \frac{1}{2}p > 0$.

Proof of Proposition 2A. Let $\hat{\sigma}_i = \hat{\sigma}_j = \sigma$ with $\sigma \leq \sigma^*$ be a regulation deterring equilibrium. Regulation is deterred when $k/c \geq ER(1, 1) - ER(\sigma, \sigma)$. Using that $\overline{\gamma}(\sigma_U) = ER(1, 1) - ER(\sigma_U, \sigma_U)$, the aforementioned inequality can be rewritten as $k/c \geq \overline{\gamma}(\sigma_U) + ER(\sigma_U, \sigma_U) - ER(\sigma, \sigma)$. Substituting (3) yields that $k/c \geq \overline{\gamma}(\sigma_U) + 2p(1 - p)r_H(\sigma_U - \sigma)$. Rearranging terms then gives

$$\sigma \geq \sigma(k/c) = \sigma_U + \tfrac{\overline{\gamma}(\sigma_U) - k/c}{2p(1-p)r_H}.$$

□

Observe that when manager i deviates to a different disclosure policy, this cannot trigger disclosure regulation. This follows from $ER(\sigma, \sigma) = ER(\sigma_i, \sigma)$ for $\sigma_i < \sigma$ and $ER(\sigma, \sigma) \leq ER(\sigma_i, \sigma)$ for $\sigma_i > \sigma$, that is, investor welfare does not decrease when manager i deviates from disclosure policy σ. Consequently, the same equilibrium conditions apply as in the unregulated setting: $\sigma \leq \min(\sigma^*(p), \sigma_H(p))$, or equivalently, $\frac{1}{2} > p \geq \max(p^*(\sigma), p_H(\sigma))$.

Because $\sigma \geq \sigma(k/c)$, it must hold that $\sigma(k/c) \leq \sigma^*(p)$ and $\sigma(k/c) \leq \sigma_H(p)$. This is equivalent to $k/c \geq \gamma^*(p, \sigma_U)$ and $k/c \geq \gamma_H(p, \sigma_U)$, respectively. Credibility of regulatory threat yields the condition $k/c \leq \overline{\gamma}(p, \sigma_U)$.

Proof of Proposition 2B. The same argument applies as in the proof of Proposition 2A. If a symmetric regulation deterring equilibrium exists, then it satisfies the equilibrium conditions of the unregulated setting. For $p \geq \frac{1}{2}$, this implies $\sigma^*(p) \geq \sigma \geq \sigma_L(p)$. In addition, σ must deter regulation so that $\sigma > \sigma(k/c)$. Because σ_U is the equilibrium policy in the unregulated setting, it holds that $\sigma_U \geq \sigma_L(p)$. Using that $\sigma(k/c) > \sigma_U$, it follows that $\sigma(k/c) > \sigma_L(p)$. Summarizing, in equilibrium, it must hold that $\sigma^*(p) \geq \sigma \geq \sigma(k/c)$. The condition $\sigma(k/c) \leq \sigma^*(p)$ is equivalent to $k/c \geq \gamma^*(p, \sigma_U)$. Credibility of regulatory threat yields the condition $k/c \leq \overline{\gamma}(p, \sigma_U)$. □

Proof of Proposition 3A.

Case 1. $\hat{\sigma}_i = \sigma(k/c) \leq \sigma^*(p)$.

Let $\hat{\sigma}_j < \hat{\sigma}_i = \sigma(k/c) \leq \sigma^*$ be a regulation deterring equilibrium. Deterrence of regulation means that $k/c \geq ER(1, 1) - ER(\hat{\sigma}_i, \hat{\sigma}_j)$, which is equivalent to $\hat{\sigma}_i \geq \sigma(k/c)$. From $\hat{\sigma}_i = \sigma(k/c)$, it follows that the regulator does not impose disclosure regulations. □

We first show when it is not optimal for manager i to choose a different disclosure policy. The expected return for the equilibrium disclosure level equals

$$\tfrac{1}{U(c)} \cdot E\left(U(\hat{\sigma}_i, \hat{\sigma}_j)\right) = \pi(\hat{\sigma}_i).$$

Choosing a more informative disclosure policy $\sigma_i > \hat{\sigma}_i$ yields expected return

$$\tfrac{1}{U(c)} \cdot E\left(U(\sigma_i, \hat{\sigma}_j)\right) = \pi(\sigma_i),$$

which is less than the equilibrium expected return if and only if $\pi(\hat{\sigma}_i) \geq \pi(\sigma_i)$. Using that $\pi(\sigma) = 1 - p + \sigma(2p - 1)$, this is equivalent to $(\hat{\sigma}_i - \sigma_i)(2p - 1) \geq 0$. Because $p < \frac{1}{2}$ and $\sigma > \hat{\sigma}_i$, this condition is satisfied.

Choosing a less informative disclosure policy σ_i triggers disclosure regulation because $\sigma_i < \sigma(k/c)$. This means that both managers will use full disclosure policies in the regulated setting so that

$$\tfrac{1}{U(c)} \cdot E\left(U(\sigma_i, \hat{\sigma}_j)\right) = E\left(U(1, 1)\right) = p(1 - pu).$$

In equilibrium, it must hold that $\pi(\hat{\sigma}_i) \geq p(1 - pu)$. Because $p \leq \frac{1}{2}$ implies $\pi(\hat{\sigma}_i) \geq p$, and because $pu \geq 0$, this inequality holds true, so that deviating to a less informative disclosure policy is suboptimal.

Next, we show when manager j does not want to choose a different disclosure policy. For manager j, the expected return equals

$$\tfrac{1}{U(c)} \cdot E\left(U(\hat{\sigma}_i, \hat{\sigma}_j)\right) = (1 - \pi(\hat{\sigma}_i)).$$

It holds that he is indifferent between any disclosure policy σ_j satisfying $\frac{1}{2} \leq \sigma_j < \hat{\sigma}_i$. Next, consider $\sigma_j = \hat{\sigma}_i$. Recall from Proposition 2A that in the symmetric equilibrium $(\hat{\sigma}_i, \hat{\sigma}_i)$ deviating to a less informative disclosure policy $\hat{\sigma}_j < \hat{\sigma}_i$ is not optimal for manager j if and only if $p \geq p_H(\hat{\sigma}_i)$. Hence, in the asymmetric equilibrium $(\hat{\sigma}_i, \hat{\sigma}_j)$, it is not optimal for manager j to choose disclosure policy $\sigma_j = \hat{\sigma}_i$ if and only if $p \leq p_H(\hat{\sigma}_i)$. Finally, consider disclosure policy $\sigma_j > \hat{\sigma}_i$. Then, the expected return equals

$$\tfrac{1}{U(c)} \cdot E\left(U(\hat{\sigma}_i, \hat{\sigma}_j)\right) = \pi(\sigma_j).$$

In equilibrium, it should thus hold that $1 - \pi(\hat{\sigma}_i) \geq \pi(\sigma_j)$ for all $\sigma_j > \hat{\sigma}_i$. This holds true, as $p \leq \frac{1}{2}$ implies that $\pi(\sigma) \leq \frac{1}{2}$ for all $\sigma \in [\frac{1}{2}, 1]$. Summarizing, manager j does not want to choose a different disclosure policy if and only if $p \leq p_H(\hat{\sigma}_i)$, or equivalently, $\hat{\sigma}_i \geq \sigma_H(p)$. Using that $\hat{\sigma}_i = \sigma(k/c)$, $\hat{\sigma}_i = \sigma(k/c) \geq \sigma_H(p)$ if and only if $\frac{k}{c} \leq \gamma_H(p, \sigma_U)$. The condition $\sigma(k/c) \leq \sigma^*(p)$ is equivalent to $k/c \geq \gamma^*(p, \sigma_U)$.

Case 2. $\hat{\sigma}_i = \sigma(k/c) > \sigma^*(p)$.

Deterrence of regulation means that $k/c \geq ER(1, 1) - ER(\hat{\sigma}_i, \hat{\sigma}_j)$, which is equivalent to $\hat{\sigma}_i \geq \sigma(k/c)$. From $\hat{\sigma}_i = \sigma(k/c)$, it follows that the regulator does not impose disclosure regulations. The condition $\sigma(k/c) \leq 1$ implies $k/c \geq \underline{\gamma}(p)$.

Manager i does not deviate to a different disclosure policy for the same reason as in the proof of case 1. For manager j, the equilibrium expected utility equals

$$\tfrac{1}{U(c)} \cdot E\left(U(\hat{\sigma}_i, \hat{\sigma}_j)\right) = (1 - \pi(\hat{\sigma}_i)),$$

which is greater than $\frac{1}{2}$ because $p < \frac{1}{2}$ implies $\pi(\hat{\sigma}_i) < \frac{1}{2}$ for all $\hat{\sigma}_i$. Observe that any disclosure policy σ_j satisfying $\frac{1}{2} \leq \sigma_j \leq \sigma^*(p)$ yields the same expected return. A disclosure policy σ_j satisfying $\sigma^*(p) < \sigma_j < \hat{\sigma}_i = \sigma(k)$ yields expected return

$$\tfrac{1}{U(c)} \cdot E\left(U(\hat{\sigma}_i, \sigma_j)\right) = \pi(\sigma_j)(1 - \pi(\hat{\sigma}_i)).$$

This is strictly less than $E(U(\hat{\sigma}_i, \hat{\sigma}_j))$ because $\pi(\sigma_j) \leq 1$. Disclosure policy $\sigma_j = \hat{\sigma}_i$ yields expected return

$$\tfrac{1}{U(c)} \cdot E\left(U(\hat{\sigma}_i, \sigma_j)\right) = \pi(\hat{\sigma}_i)(1 - \pi(\hat{\sigma}_i)u),$$

which is less than $\frac{1}{2}$ as $\pi(\hat{\sigma}_i) \leq \frac{1}{2}$ and $(1 - \pi(\hat{\sigma}_i)u) < 1$. Hence, mimicking the disclosure policy of manager i does not pay off. Finally, consider the disclosure policy $\sigma_j > \hat{\sigma}_i$. This yields

$$\tfrac{1}{U(c)} \cdot E\left(U(\hat{\sigma}_i, \sigma_j)\right) = \pi(\sigma_j).$$

Again, this alternative yields a utility less than $\frac{1}{2}$ because $\pi(\sigma_j) < \frac{1}{2}$. Summarizing, manager j does not want to choose a different disclosure policy.

Concluding, an asymmetric regulation deterring equilibrium exists when $1 \geq \sigma(k/c) > \sigma^*(p)$. These inequalities are equivalent to $\underline{\gamma}(p) \leq k/c \leq \gamma^*(p, \sigma_U)$.

Proof of Proposition 3B. The proof is similar to the proof of Proposition 3A Case 2. The only difference is that because $p \geq \frac{1}{2}$, manager i prefers full disclosure over the disclosure policy $\sigma(k/c)$.

Let $\hat{\sigma}_j \leq \sigma^* < \hat{\sigma}_i = 1$ and $\sigma(k/c) \leq 1$ be a regulation deterring equilibrium. First, consider manager i. The expected return for manager i equals

$$\tfrac{1}{U(c)} \cdot E\left(U(\hat{\sigma}_i, \hat{\sigma}_j)\right) = p.$$

Choosing a less informative disclosure policy σ_i satisfying $\sigma(k/c) \leq \sigma_i < 1$ still deters regulation so that the expected return equals

$$\tfrac{1}{U(c)} \cdot E\left(U(\sigma_i, \hat{\sigma}_j)\right) = \pi(\sigma_i).$$

In equilibrium, it should hold that $p \geq \pi(\sigma_i)$. Substituting $\pi(\sigma_i) = 1 - p + \sigma_i(2p - 1)$ yields $(2p - 1)(1 - \sigma_i) \geq 0$, which holds true because $p \geq \frac{1}{2}$. □

For a disclosure policy σ_i satisfying $\frac{1}{2} \leq \sigma_i < \sigma(k/c)$, disclosure regulation arises yielding expected return of

$$\frac{1}{U(c)} \cdot E\left(U(\sigma_i, \hat{\sigma}_j)\right) = p(1 - pu),$$

which is clearly less than the equilibrium expected return $\frac{1}{U(c)} \cdot E(U(\hat{\sigma}_i, \hat{\sigma}_j)) = p$.

Next, let us turn to manager j. His expected return equals

$$\frac{1}{U(c)} \cdot E\left(U(\hat{\sigma}_i, \hat{\sigma}_j)\right) = (1 - p).$$

He is indifferent between any disclosure policy σ_j satisfying $\frac{1}{2} \leq \sigma_j \leq \sigma^*(p)$. His expected return is strictly less for disclosure policies σ_j satisfying $\sigma^*(p) < \sigma_j < 1$. When manager j mimics the full disclosure policy of manager i, his expected return equals

$$\frac{1}{U(c)} \cdot E\left(U(1, 1)\right) = p(1 - pu).$$

This is worse than the equilibrium expected return if and only if $p \leq p_{FD}$. Recall that in a full disclosure setting, manager j does not want to use a less informative disclosure if and only if $p \geq p_{FD}$.

Summarizing, manager i does not want to use a less informative disclosure policy; manager j does not want to use a full disclosure policy if and only if $p \leq p_{FD}$. An asymmetric regulation deterring equilibrium exists when $1 \geq \sigma(k/c) > \sigma^*(p, \sigma_U)$. These inequalities are equivalent to $\underline{\gamma}(p) \leq k/c \leq \gamma^*(p, \sigma_U)$.

Appendix B

In this paragraph, we explain and present the (pure-strategy) regulation deterring equilibrium when, without the threat of regulation, the mixed-strategy equilibrium cf. Proposition 1D results. As for the pure-strategy equilibria, let σ_U denote the unregulated mixed equilibrium.

Proposition 4. Let σ_U be the mixed-strategy disclosure precision equilibrium in the unregulated setting, so that $p_L(\sigma^*) \leq p \leq p_{FD}$. Then, $(\hat{\sigma}_i, \hat{\sigma}_j)$ with $\hat{\sigma}_j \leq \sigma^*(p) < \hat{\sigma}_i = 1$ is an asymmetric regulation deterring disclosure equilibrium if and only if $\underline{\gamma}(p) \leq k/c < \overline{\gamma}(p, \sigma_U)$.

Proof. The proof is similar to the proof of Proposition 3B. First, note that this equilibrium can only result for $p_L(\sigma^*) \leq p \leq p_{FD}$. The expected return for the investor exceeds the expected return of all symmetric equilibria $\hat{\sigma}$ with $\hat{\sigma} \leq \sigma^*$. Therefore, if the threat of regulation is credible, the most informative disclosure should exceed σ^*. This implies that a symmetric deterring equilibrium is not possible. Only an asymmetric equilibrium can arise and given that $p \geq \overline{p} \geq \frac{1}{2}$, manager i, prefers full disclosure. This yields the only possible candidate equilibrium $(1, \hat{\sigma}_j)$.

The equilibrium $(1, \hat{\sigma}_j)$ is not sustainable if $p > p_{FD}$, as then firm j would prefer full disclosure (as indicated in the proof of Proposition 3B). Next, consider $\hat{\sigma}_j > \sigma^*(p)$. This equilibrium is also not sustainable, because manager j only gets capital when i generates the bad report *and* j generates the good report. When deviating to full disclosure, the probability of a good report is higher and firm j also gets capital when firm i discloses a good report.

The condition $\hat{\sigma}_j < \sigma^*(p)$ is equivalent to $k/c \geq ER(1, 1) - ER(1, \sigma^*) = \underline{\gamma}(p)$. The relevant upper bound for this equilibrium to hold is that of the credible threat of regulation, that is, $\overline{\gamma}(p, \sigma_U)$. □

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