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Enforcement and disclosure ☆

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ABSTRACT

Absent sufficient enforcement, disclosure regulations are often seen as inconsequential. However, enforcement could have unintended effects on firms' incentives to disclose information voluntarily. We develop a model to analyze the impact of enforcement on firms' mandatory and voluntary disclosure behavior. The model can accommodate different disclosure and enforcement regimes depending on its parameters, ranging from voluntary disclosure under stochastic information endowment to disclosure under an enforcement regime with punitive damages. In the generalized version, low-value firms disclose under a mandatory disclosure rule, medium-value firms do not disclose (some legally, some illegally), and high-value firms disclose voluntarily. Stronger enforcement does indeed increase the number of firms complying with the regulation. However, it also crowds out voluntary disclosure by making separation less attractive, resulting in a decrease in transparency overall. Nevertheless, stronger enforcement does still lead to positive capital market effects, such as lower mispricing. When we endogenize disclosure regulation, i.e., determine the rule according to firms' preferences, there exists a unique standard where no majority prefers a marginal change to the regulation, and that increases in enforcement.

1. Introduction

Thinking about disclosure regulation without a supporting enforcement system is fragmentary. Enforcement does not only scrutinize transparency and thus, the availability of information ex-post, but also affects firms' reporting strategies ex-ante in anticipation of potential enforcement actions (e.g., Hillegeist, 1999; Ewert and Wagenhofer, 2019). The observed monetary fines for uncovered, non-compliant firms are also sizable. For example, between 2015 and 2019, the Securities and Exchange Commission (SEC) mandated on average $2.908 billion in disgorgement of ill-gotten gains and imposed $1.164 billion in penalties for 822 enforcement actions annually (SEC, 2019). Absent sufficient enforcement, disclosure regulations are often seen as inconsequential (e.g., Hope, 2003; Holthausen, 2009; Christensen et al., 2013, 2016; Leuz and Wysocki, 2016). However, stronger enforcement could also result in a crowding out of firms' voluntary disclosure practices because disclosure regulations become more efficient, creating tension regarding the role of enforcement for transparency overall.

We present a theoretical model that considers firm-specific enforcement of mandatory disclosure regulation to analyze its impact on firms' disclosure behavior. The model combines voluntary disclosure with stochastic information endowment, as proposed by

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Dye (1985) or Jung and Kwon (1988), with an asymmetric mandatory disclosure rule with probabilistic enforcement. Firms with a value below a prescribed threshold are required to disclose according to regulations and are subject to potential enforcement actions, whereas firms above the threshold can disclose voluntarily. We show that low-value firms disclose under mandatory disclosure regulations, medium-value firms remain silent, and high-value firms separate by means of voluntary disclosure. This pattern resembles empirical findings concerning firms' disclosure behavior around specific implicit or explicit thresholds, such as the observed discontinuity in the earnings distribution (Burgstahler and Dichev, 1997; Bollen and Pool, 2009; Bennett et al., 2017).

An in-depth analysis yields further insights, which also provide guidance for future empirical work. First, the set of non-disclosing firms differs from traditional disclosure models. As is common, the non-disclosure set consists of uninformed and informed firms that are not required to disclose and lack incentives to do so voluntarily. Additionally, in our model, the non-disclosure set also contains firms that do not comply with mandatory disclosure. This is the result of considering probabilistic enforcement with penalties instead of, for example, verification costs (e.g., Bertomeu et al., 2021b). Second, stronger enforcement widens the set of firms that comply with mandatory disclosure regulations, where increasing the probability of detection is more efficient in inducing compliance than increasing penalties. The former affects not only the penalty payment when detected, but also firms' chances of becoming subject to enforcement in the first place. Third, enforcement of mandatory disclosure connects all firms' disclosure decisions, irrespective of whether they are mandated to disclose or not. Stronger enforcement increases the average value of firms that remain silent and thus, the non-disclosure price. As a consequence, fewer firms disclose voluntarily as separation becomes less beneficial. Fourth, transparency in an economy decreases as fewer firms disclose private information after the enforcement stage. Although stronger enforcement results in more compliance with mandatory disclosure regulations, this comes at the cost of crowding out voluntary disclosure. However, when additionally considering the related capital market effects, average mispricing in the economy decreases in enforcement overall. Lastly, enforcement shapes firms' demand for disclosure regulation as an economic institution. Specifically, compliant and non-compliant medium-value firms shape disclosure regulation, demanding that more firms become subject to disclosure when enforcement increases. That is, the equilibrium threshold of the asymmetric disclosure regime increases monotonically in enforcement.

Our study contributes to a large strand of disclosure theory research, tracing back to Grossman and Hart (1980) and Milgrom (1981). Our setting relates to Dye (2002), where firms can manipulate classifications prescribed by accounting standards at a cost. Allowing for misconduct results in different de facto classifications, and some firms receive a more favorable valuation than under a strict application of the accounting standards. In our model, a similar compliance threshold emerges due to probabilistic enforcement, showing that enforcement is not sufficiently strong to always deter misconduct. Our paper also relates to studies analyzing the interplay of mandatory and voluntary disclosure in sender-receiver persuasion games. Bertomeu et al. (2021a) focus on the optimal design of the internal accounting information generating process for given incentives to strategically withhold bad news. They vary the information generation process and compare a benchmark model, where the regulator would always rely on a precise signal, to one, where an imprecise signal reduces the disclosure threshold. Overall, this implies that more transparency comes with less precise information.[1] While our model shares certain features, such as probabilistic information endowment, strategic withholding incentives, and a penalty system, our focus is different. Bertomeu et al. (2021a) focus on ensuring that firms remaining silent do so legally, while we concentrate on the effects of the means to uncover those who remained silent illegally. As such, we turn to the effects of enforcement on the interplay between mandatory and voluntary disclosure for a given reporting system. A further difference results from our assumption of probabilistic enforcement. As the detection probability is not fixed, we are able to analyze the impact of an enforcement system's intensity. Moreover, enforcement penalties are not constant but vary with firm characteristics too. Hence, we can analyze the impact of enforcement strength.

Friedman et al. (2020) analyze the relation between the design of the reporting system and firms' disclosure behavior. They also assume probabilistic information endowment, with the manager having a meet (or beat)-objective function. Their endogenously determined reporting system exhibits conservative properties similar to the mandatory disclosure regulation assumed in our model. The firm implements an impairment-like reporting system that provides a good report for all states above a certain threshold to prevent being punished for non-disclosure. In contrast to our model, two pieces of information exist. On the first stage, the design of the reporting system becomes publicly observable, reducing the receivers informational disadvantage as conditional distributions over future states of the world are communicated upfront. On the second stage, a perfectly informative signal might be observed and potentially reported. The firm's choice concerns additional voluntary disclosure, whereas firms in our model differ with respect to the disclosure channel and the thread from imperfect enforcement.

Bertomeu et al. (2021b) ask whether an accounting policy should require firms to disclose bad news when it is perfectly enforceable, and consider disclosure costs as a means to generate a partial disclosure equilibrium. Importantly, they focus on settings where disclosure has social value, whereas we introduce probabilistic enforcement to study the effect of the ex-post verification mechanism on disclosure. Nevertheless, our approach is inherently related because enforcing an asymmetric mandatory disclosure regulation also results in the disclosure of bad news. Bertomeu et al. (2021b) show that mandatory disclosure excludes bad-type firms from the non-disclosure set, hence preventing excessive voluntary disclosure. While excessive disclosure would not be an issue in our model, as we do not assume any direct disclosure costs, we observe the same pattern under probabilistic enforcement, with mandatory crowding out voluntary disclosure. Although stronger enforcement can result in less transparency, i.e., fewer firms disclose overall, the average amount of mispricing in the economy decreases too. Lastly, the interpretation of mandatory disclosure is different. Bertomeu et al. (2021b) refer to information that otherwise would not have been disclosed, whereas mandatory disclosure in our

[1] See Bertomeu et al. (2021a), Proposition 1, p. 1539.

model defines the firms that are potentially subject to enforcement actions.[2] Accordingly, in their model, verification costs apply to ensure that a firm is not subject to mandatory disclosure, and remaining silent illegally is impossible. In contrast, ex-post verification in our model does not focus on the firms slightly above the mandatory disclosure threshold but on those below it, with detection probabilities and liability payments being firm-specific.

Our partial disclosure pattern further contrasts with Aghamolla et al. (2021), who provide a counter-signaling argument when it comes to earnings guidance. In their model, low-value firms can disclose only with imperfection and, thus, prefer to remain silent. High-value firms, in turn, can separate best from medium-value firms by remaining silent, too. Thus, the disclosure behavior at the top of the value distribution in our and their model is similarly driven by the desire to separate from medium-value firms, but the resulting disclosure patterns are inverted.

Other studies focusing on the interplay of mandatory and voluntary disclosure include Einhorn (2005) and Versano (2021). The former considers that firms can observe two signals, one being reported mandatorily and the other voluntarily, but without considering enforcement. The interplay originates from the correlation of both signals and applies to an individual firm. Our setting analyzes the interplay across firms, where the non-disclosure price that responds to the level of enforcement in an economy affects the voluntary disclosure of firms at the top of the value distribution. In contrast, Versano (2021) considers the optimal disclosure channel when reporting soft information. Further, voluntary disclosure might be restricted by past reporting decisions and thus, exhibit mandatory characteristics to a certain extent. Papers considering such intertemporal trade-offs are, for instance, Einhorn and Ziv (2008) or Cianciaruso and Sridhar (2018). A different type of trade-off is in Suijs (2005), who considers disclosure costs leading to a partial disclosure equilibrium when facing a strategic opponent. Whenever direct disclosure costs are low, bad information is disclosed to avoid high proprietary costs.

Lastly, considering the local stability of the mandatory disclosure thresholds relates to a stream of literature on endogenous disclosure rules and accounting standards (e.g., Bertomeu and Cheynel, 2013; Bertomeu and Magee, 2015b; Bertomeu et al., 2019). For instance, Bertomeu and Magee (2015a) show that a majority of firms prefers an asymmetric disclosure regime that mandates firms to disclose unfavorable and withhold favorable information. Chen and Yang (2022) analyze the evolution of accounting regulation in a dynamic voting model, documenting that a high-disclosure regime is more robust to deviation from a steady-state. Our model differs from the above studies because we consider a setting in which both a firm's private information and enforcement intensity and strength drive a firm's preference toward disclosure regulation.

The remainder of the paper is organized as follows: Section 2 introduces the model. Section 3 provides the analysis of the model, relates the results to various disclosure settings, and discusses implications. Section 4 concludes.

2. The model

We consider a continuum of firms run by risk-neutral owner-managers who aim to maximize their firms' market values through disclosure. Each firm is represented by its firm value, v_i, with the corresponding random variable v being uniformly distributed, i.e., $v \sim \mathcal{U}[0,1)$. Each firm receives private information that may either reveal its true value, $\Phi_i = v_i$, or is not informative, $\Phi_i = \emptyset$. With probability $p \in [0,1]$, the private information is not informative about the firm value, and with probability $(1-p)$ it is (Dye, 1985; Jung and Kwon, 1988).

If a firm is not endowed with information, no disclosure takes place. Otherwise, it will either (i) disclose under a mandatory disclosure regulation, (ii) disclose the private information voluntarily, or (iii) remain silent. The latter option relaxes the common truth-telling assumption by enabling firms to also remain silent in case they are mandated to disclose.[3] Following prior literature, we assume that if firms disclose, they do so truthfully. We abstain from earnings management as it has no impact on mandatory disclosure with probabilistic information endowment. A bias in voluntary disclosure would also be monotonically increasing and could be perfectly backed out by investors (see, Einhorn and Ziv, 2012, pp. 429).

The mandatory disclosure regulation is asymmetric in nature, reflecting the common conservatism principle in accounting (e.g., Chen et al., 2007; Göx and Wagenhofer, 2009; Bertomeu and Magee, 2015a). A firm is mandated to disclose if its realized firm value, v_i, falls short of a prescribed threshold A, with $A \in (0,1)$. In contrast, firms are not required to convey private information if $v_i \geq A$. Voluntary disclosure is still feasible for those firms. When remaining silent, the market cannot distinguish between firms with and without private information.

Mandatory disclosure is subject to probabilistic enforcement, with the probability of being uncovered representing any action by security regulators, auditors, the media, or others that can reveal misconduct (e.g., Coffee, 1986; Miller, 2006; Karpoff et al., 2008a,b; Dyck et al., 2010). We denote the basic detection probability of a non-compliant firm i by $\phi_i \in [0,1]\ \forall v_i \in [0,A)$. If a firm's misconduct is detected, it must publicly restate its value v_i and pay a penalty, which is a function of the damage caused.[4] In the model, the penalty D_i is the difference of the expected non-disclosure price, $E(v|ND)$, and the non-compliant firm's true value, v_i, multiplied by a scaling factor $\rho \geq 1$ to capture differences in litigation strength. For $\rho = 1$, the penalty resembles a compensatory

[2] See Bertomeu et al. (2021b) Definition 2 (ii) on p. 663.

[3] For a similar application of a relaxed truth-telling condition see, e.g., Ebert et al. (2017).

[4] The penalty reflects the harm done to investors or the firm's ill-gotten gains from being non-compliant (see, SEC, 2006 for guidelines and Karpoff et al. (e.g., 2007) for empirical evidence).

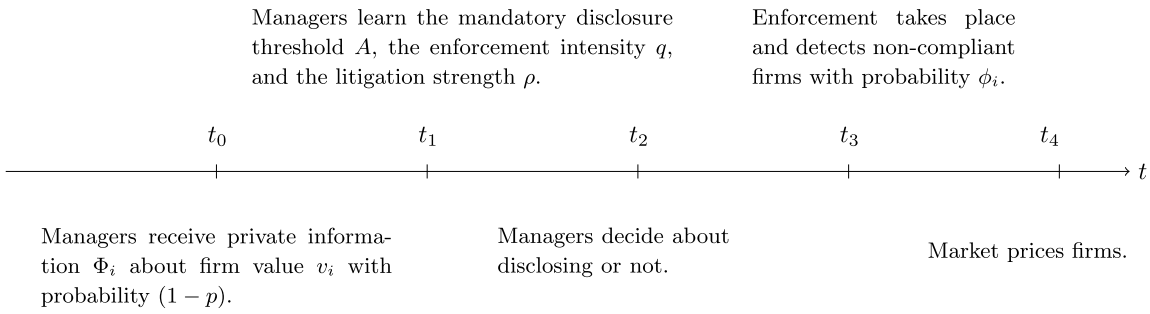


Fig. 1. Timeline.

damage ensuring that the firm at least has to give up the caused damages. For $\rho > 1$, the penalty becomes a punitive damage.[5] Thus, the stronger litigation, the larger ρ and the larger the penalty D_i, all else equal. The firm-specific penalty payment is:

$$D_i = \rho \left[E(v|ND) - v_i \right], \tag{1}$$

which is paid to the responsible authorities and reduces the firm value accordingly.

The *expected* penalty λ_i of a firm i for illegally remaining silent is the product of the detection probability ϕ_i and the penalty D_i:

$$\lambda_i = \phi_i D_i. \tag{2}$$

The firm-specific detection probability increases in the severity of a firm's misconduct, i.e., the detection probability is the scaled distance between the disclosure threshold A and a firm's value v_i multiplied by a factor $q \in (\frac{1}{2}, 1]$ to capture differences in enforcement intensity. The firm-specific detection probability is:

$$\phi_i = q \left(\frac{A - v_i}{A} \right) \ \forall v_i < A. \tag{3}$$

Overall, the expected penalty of firm i becomes:

$$\lambda_i = q \left(\frac{A - v_i}{A} \right) \cdot \rho \Big(E(v|ND, q, \rho) - v_i \Big). \tag{4}$$

Fig. 1 summarizes the sequence of events: In t_0, firms potentially receive relevant private information about their true firm value. In t_1, firms observe the mandatory disclosure threshold A. Given the mandatory disclosure threshold and the enforcement regime in place, firms decide to disclose or not in t_2. In t_3, enforcement actions take place and uncovered firms restate publicly and pay the damage. At last, prices are determined in a competitive market in t_4.

3. Analysis

3.1. A partial disclosure equilibrium

We focus on searching for a threshold-like disclosure equilibrium featuring mandatory and voluntary disclosure under imperfect enforcement. The rationale for a threshold-like partial disclosure equilibrium is as follows. Information endowment is probabilistic, meaning that two types of non-disclosing firms exist: (i) informed firms that abstain from disclosure and (ii) uninformed firms. The non-disclosure price reflects investors' uncertainty about the information endowment and is given by the expected valuation of all non-disclosing firms. Because uninformed, high-value firms remain in the non-disclosure set, unraveling of firm values via voluntary disclosure stops at a disclosure threshold (e.g., Jung and Kwon, 1988), which we denote v_{vol}. Only firms with more favorable private information, i.e., $v > v_{vol}$, separate through voluntary disclosure. Firms with less favorable private information, i.e., $v \leq v_{vol}$, do not disclose voluntarily and become, from an investor's perspective, indistinguishable from uninformed, high-value firms.

Firms hiding unfavorable information is a common argument for mandatory disclosure regulation and its enforcement (e.g., Beyer et al., 2010). Introducing a mandatory disclosure threshold A under probabilistic enforcement incentivizes some firms with $v < A$ to reveal their private information. However, imperfect enforcement will not result in truth-telling as long as the expected penalties for non-compliance become prohibitively high. As such, there exists a compliance threshold v_{com} representing the value of the firm i that is indifferent between complying with mandatory disclosure and concealing its true value. Informed firms with $v < v_{com}$ comply with the mandatory disclosure regulation, anticipating expected penalties from non-compliance that exceed the expected benefits of concealing their private information. However, this incentive effect of enforcement becomes weaker for firms closer to the mandatory

[5] The parameter allows us to analyze different enforcement penalties. Punitive damages are awarded against defendants guilty of malicious misconduct. However, in most settings, including the US, misconduct related to disclosure violations has usually not been considered to be of this type, limiting recovery to actual damages.

threshold A because the expected costs of enforcement decrease. Informed firms with $v_{com} \leq v < A$ still try to hide their type, facing the risk of an enforcement action.

Thus, we look for a partial disclosure equilibrium featuring three thresholds: (i) a voluntary disclosure threshold v_{vol}, (ii) a mandatory disclosure threshold A, and (iii) a compliance threshold v_{com}. The set of non-disclosing firms consists of *legally* and *illegally* silent firms. Legally silent firms are neither endowed with private information nor legally required to disclose under the mandatory regulation, i.e., $A < v \leq v_{vol}$. In contrast, firms are illegally silent if they receive private information that must be revealed under the mandatory disclosure regulation, but refuse to comply, i.e., $v_{com} \leq v < A$.

For a partial disclosure equilibrium featuring compliant, non-compliant, and voluntary-disclosing firms to exist, it needs to hold that $0 < v_{com} < A < v_{vol} < 1$. Proposition 1 provides the disclosure thresholds for the partial disclosure equilibrium.[6]

Proposition 1. *A partial disclosure equilibrium is characterized by a mandatory disclosure threshold, A, a compliance threshold, $v_{com} = A\left(1 - \frac{1}{(1+\rho)q}\right)$, and a voluntary disclosure threshold, $v_{vol} = \alpha A - \frac{p}{1-p} + \sqrt{\left[\alpha A - \frac{p}{1-p}\right]^2 - \left[\beta A^2 - \frac{p}{1-p}\right]}$.*

Proof. See Appendix B. □

Lemma 1 further provides the necessary condition for its existence. While $v_{com} \in [0, A]$ holds for $q \in (\frac{1}{2}, 1]$ and $\rho \geq 1$, preventing complete unraveling from the top further requires $A < v_{vol}$. The mandatory disclosure threshold A needs to be sufficiently low to ensure that some firms above the threshold remain silent in equilibrium, introducing an upper bound, A_{crit}, on the mandatory disclosure threshold. For $A < A_{crit}$, the partial disclosure equilibrium featuring compliant and non-compliant mandatory disclosure and voluntary disclosure exists. In contrast, for $A \geq A_{crit}$, $v_{vol} \leq A$ follows, meaning that all firms above the mandatory threshold A report voluntarily. Because there are no informed, high-value firms above the mandatory threshold available for pooling, the disclosure incentives for firms below the threshold change. Essentially, because the region between A and v_{vol} becomes non-existent, an unraveling motion is triggered.

Lemma 1. *A partial disclosure equilibrium featuring compliant and non-compliant mandatory disclosure and voluntary disclosure characterized by $0 < v_{com} < A < v_{vol} < 1$ exists iff $A < A_{crit}$, with $A_{crit} = -\frac{p}{(1-p)}\frac{1}{(1-2\alpha+\beta)} + \sqrt{\left[\frac{p}{(1-p)}\frac{1}{(1-2\alpha+\beta)}\right]^2 + \frac{p}{(1-p)}\frac{1}{(1-2\alpha+\beta)}}$.*

Proof. See Appendix C. □

Corollary 1 characterizes firms' disclosure behavior in the partial disclosure equilibrium. For firms at the top of the value distribution, voluntary disclosure follows the traditional Grossman (1981) unraveling pattern that stops at a certain threshold because of the Dye-type information endowment friction. Firms at the bottom of the value distribution are subject to mandatory disclosure, with enforcement pressure increasing in the distance to the mandatory disclosure threshold A, resulting in the compliance threshold. These patterns overlap when $A \geq A_{crit}$, resulting in full disclosure by all informed firms. Otherwise, firms in the middle of the value distribution remain silent. While enforcement is probabilistic in our setting, the unraveling structure is similar to Bertomeu et al. (2021b): the last type of news to be disclosed is the intermediate type. However, our unraveling pattern is not driven by disclosure costs, but by weakened incentives to separate from the non-disclosure set.

Corollary 1. *Let $A < A_{crit}$, firms with $v \in [0, v_{com})$ comply whereas firms with $v \in (v_{com}, A)$ do not comply with the mandatory disclosure. Firms with $v \in (A, v_{vol})$ do not disclose while also not being obliged, and firms with $v \in (v_{vol}, 1]$ disclose voluntarily.*

3.2. Discussion

We next demonstrate that our generalized model covers well-known disclosure settings as special cases.[7] We then make use of these settings to discuss firms' disclosure choices and elaborate on the implications for transparency and pricing in an economy.

3.2.1. Disclosure thresholds

In our model, a voluntary disclosure setting resembling Dye (1985) or Jung and Kwon (1988) materializes when we set the mandatory disclosure threshold to zero, i.e., $A = 0$. Non-compliance cannot exist and all firms at the bottom of the value distribution face incentives to remain silent. This *voluntary disclosure setting* yields the following thresholds based on Proposition 1:

$$v_{com} = 0, \text{ and } v_{vol} = \frac{\sqrt{p} - p}{1 - p}. \tag{5}$$

[6] Appendix B also provides the full expressions based on the exogenous variables of the model.

[7] In a setting with a strategic opponent and positive disclosure costs, disclosing bad news depends on the ratio of direct and proprietary disclosure costs (Suijs, 2005). We show in Appendix D that our results also hold when considering direct disclosure cost instead of a probabilistic information endowment friction.

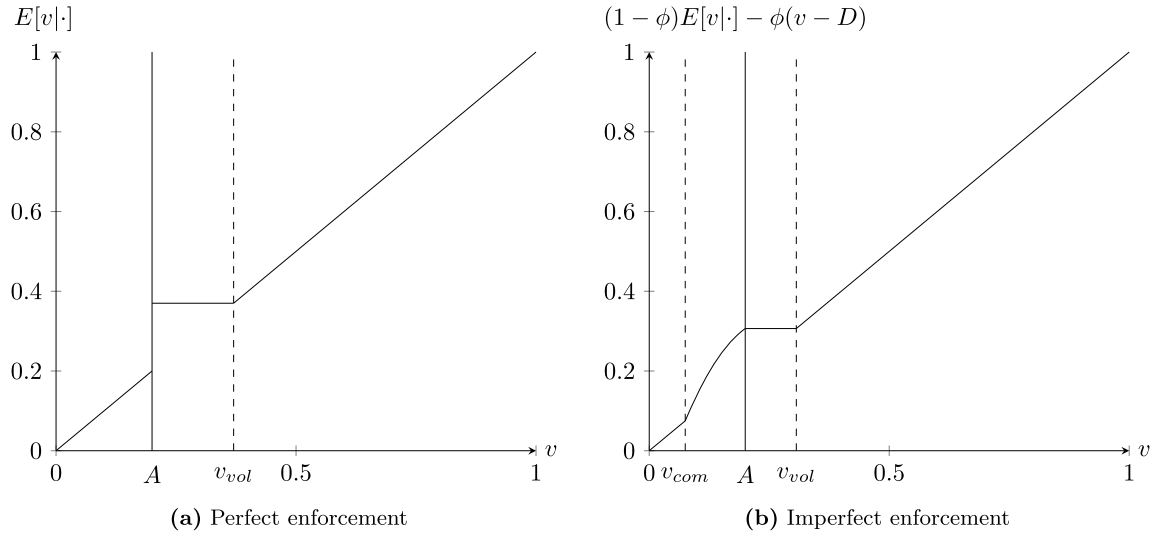


Fig. 2. Firms' expected valuations under different enforcement regimes.

When voluntary and mandatory disclosure exist in parallel, spillover effects between the two types of disclosures arise (see, e.g., Einhorn, 2005). Upholding the common assumption of truth-telling translates into $\alpha = \beta = 1$ in Proposition 1, resulting in a *voluntary and mandatory disclosure setting under perfect enforcement*. The disclosure thresholds become:

$$v_{com} = A, \text{ and } v_{vol} = A - \frac{p}{1-p} + \sqrt{\left(A - \frac{p}{1-p}\right)^2 - \left(A^2 - \frac{p}{1-p}\right)}. \tag{6}$$

Comparing (5) and (6) highlights that enforcement connects firms' disclosure behavior at the bottom and the top of the value distribution. The mandatory disclosure regime influences voluntary disclosure by altering the set of non-disclosing firms. Requiring more firms to disclose, i.e., by increasing A, forces more low-value firms with $v < A$ to disclose, resulting in a higher valuation of non-disclosing firms. But the increase of the non-disclosure pooling price makes separation less attractive to firms with $v > A$ and thus, increases the voluntary disclosure threshold. Moreover, transparency increases under joint voluntary and mandatory disclosure with perfect enforcement because the non-disclosure set shrinks compared to the setting under sole voluntary disclosure.[8] While higher non-disclosure prices and more transparency appear desirable, they hinge on the unsustainable assumption of perfect enforcement.

Fig. 2 depicts firms' expected valuations under perfect and imperfect enforcement as characterized by our model. The illustration highlights how firms' leeway to remain silent under the mandatory disclosure regulation creates new disclosure incentives. Disclosing firms reside at the bottom and the top of the value distribution, whereas silent firms appear in the middle. Intuitively, informed firms' choice to abstain from mandatory disclosure at a certain cost grows the non-disclosure set relative to perfect enforcement. Moreover, the relation between voluntary and mandatory disclosure is affected because incentives to comply with mandatory disclosure rules or disclose voluntarily are driven by the non-disclosure price.[9] Thus, the composition of the non-disclosure set changes, too.

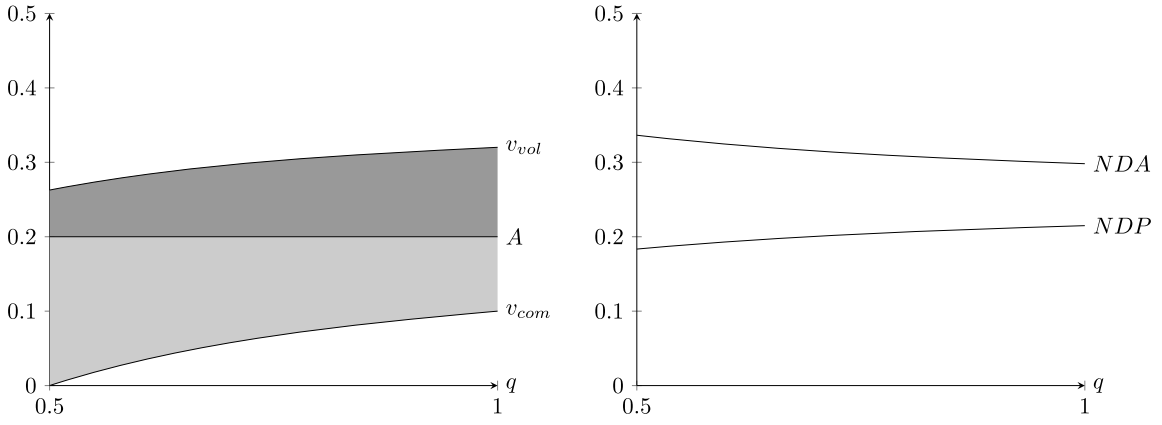
Historically, problems of varying enforcement intensities and strength are recurring ones (e.g., Hillegeist, 1999; Zeff, 2003a,b; Fox, 2009). To get a clearer view on the effects of imperfect enforcement, we next unmute each enforcement parameter at a time. For $q = \rho = 1$, the model resembles a disclosure setting featuring *voluntary and mandatory disclosure with firm-specific enforcement intensity and compensatory damages*. In this case, the thresholds are:

$$v_{com} = \frac{1}{2}A, \text{ and } v_{vol} = \frac{5}{8}A - \frac{p}{1-p} + \sqrt{\left(\frac{5}{8}A - \frac{p}{1-p}\right)^2 - \left(\frac{7}{16}A^2 - \frac{p}{1-p}\right)}. \tag{7}$$

The mandatory disclosure threshold A does not separate disclosing from non-disclosing firms anymore, but compliant from non-compliant firms within the non-disclosure set. Firms close to the threshold stop complying with mandatory disclosure regulations as expected benefits from remaining silent still exceed expected enforcement penalties. As the expected set of non-disclosing firms now contains firms of lower value, separation via voluntary disclosure becomes more attractive, decreasing the voluntary disclosure threshold compared to (6).

[8] Comparing the size of the non-disclosure set under sole voluntary disclosure, i.e., $v_{vol} - 0$, and the current case, i.e., $v_{vol} - A$, yields $p^2 < p$. This condition holds $\forall p < 1$.

[9] An alternative interpretation of "imperfect enforcement" could imply wrongful enforcement actions against non-disclosing firms with $A < v < v_{vol}$. The potential for wrongful enforcement actions would result in a decrease in the voluntary disclosure threshold. Voluntary disclosure becomes more attractive to firms above the mandatory threshold when wrongful enforcement imposes costs on legally non-disclosing firms.



(a) Composition of disclosing and non-disclosing firms **(b)** Size of ex-ante and ex-post non-disclosure sets

Fig. 3. Transparency implications.

When varying enforcement intensity and strength, the thresholds of the general model presented in Proposition 1 follow. Both enforcement intensity q and strength ρ affect firms' behavior in equilibrium and act as substitutes. Moreover, the connection of firms on opposite sides of the value distribution via enforcement becomes even more apparent: increasing either of the parameters induces more compliant behavior at the lower end and reduces incentives for voluntary disclosure at the upper end of the value distribution. However, their efficiency in deterring non-compliant behavior differs. Consider the expected value of non-compliant behavior for a given firm i with $v_i < A$:

$$\Big(1-\phi_i(q)\Big)E(v|ND,q,\rho)+\phi_i(q)\Big(v_i-\rho\Big[E(v|ND,q,\rho)-v_i\Big]\Big). \tag{8}$$

Both parameters affect the potential payoff via the pooling price, but the detection probability ϕ_i is driven by enforcement intensity alone. As such, enforcement intensity induces compliance through two channels, whereas enforcement strength only through one channel. Using the resulting compliance threshold v_{com}:

$$v_{com}=\left(1-\frac{1}{(1+\rho)q}\right)A \tag{9}$$

and comparing the first-order derivatives of the threshold towards each of the parameters, respectively, we find that intensity is more efficient in inducing compliant firm behavior.

Lemma 2. *An increase in enforcement intensity q is more effective than an increase in enforcement strength ρ in inducing compliant disclosure behavior.*

Proof. See Appendix E. □

The combination of the detection channel and the penalty channel gives enforcement intensity the edge over enforcement strength in our setting. The effect of strength is limited to the penalty channel, which can only incentivize firms to comply via the expected penalty once a firm's misconduct is detected. As such, regulators might want to focus on firms' detection probability instead of increasing penalties to achieve compliance efficiently.

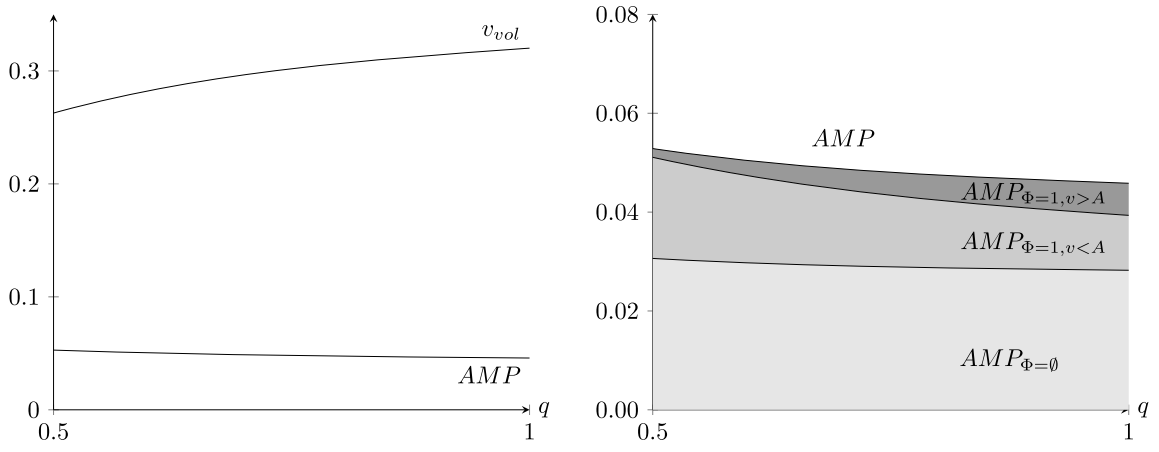
3.2.2. Transparency and pricing implications

We next turn to the implications of enforcement for transparency, i.e., the extent of private firm information being revealed to the public, and pricing in an economy.[10] Whereas the former focuses on the set of firms revealing private information, the latter adds pricing considerations to assess the overall impact. We base our discussion on a numerical implementation of the general model, focusing on enforcement intensity q. We set enforcement strength to $\rho = 1$, resembling compensatory damages as employed by most enforcement regimes' treatment of disclosure-related misconduct, such as in the US and most European countries.[11]

Fig. 3a highlights the implications of enforcement intensity on the composition of disclosing and non-disclosing firms in the economy. As expected, an increase in enforcement intensity q results in an increase in the compliance threshold v_{com} and more firms

[10] See Cheynel (2013) for analyzing the impact of voluntary disclosure on the cost of capital with probabilistic information endowment. Because mandatory disclosure partially resolves uncertainty, in our setting, analyzing mispricing should be more instructive.

[11] We provide the analytical expressions for the transparency and mispricing metrics in Appendix F. Note that the higher-order polynomials cause non-monotone conditions. Results are similar when focusing on enforcement strength ρ instead of enforcement intensity q.



(a) Non-disclosure price and average mispricing **(b)** Components of average mispricing

Fig. 4. Pricing implications.

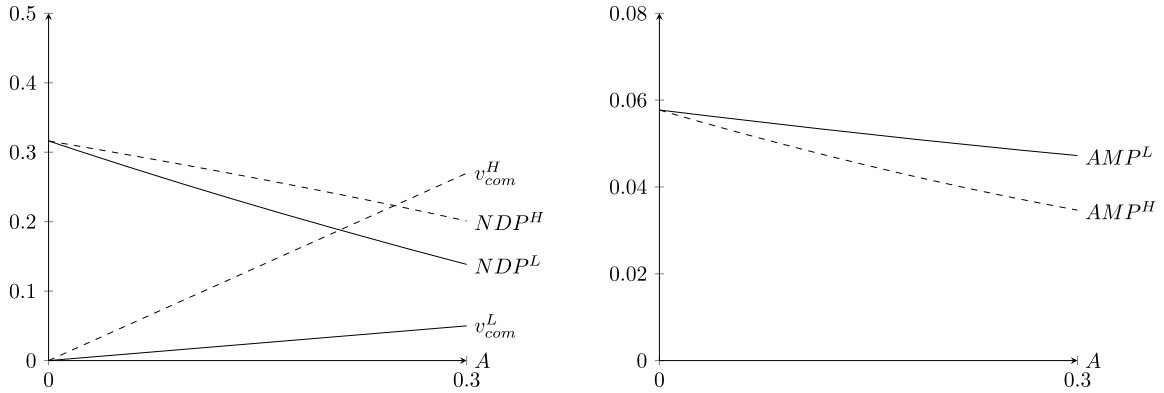
at the bottom of the value distribution disclosing their private information. In response, voluntary disclosure becomes less attractive because the non-disclosure price, and thus, the voluntary disclosure threshold v_{vol}, increases too. However, the increase of v_{vol} in q is slower than the one of v_{com} such that the overall set of informed, non-disclosing firms shrinks. Moreover, the figure illustrates that, although stronger enforcement results in less illegal behavior, this comes at the cost of a crowding out voluntary by mandatory disclosure in the economy. The set of firms that illegally remain silent shrinks (light gray area) whereas the set of firms that legally remain silent expands (dark gray area). Firms at the bottom of the value distribution start disclosing more, whereas firms at the middle of the value distribution stop disclosing voluntarily.

Because the disclosure thresholds only describe the borders of the sets of informed, non-disclosing firms, Fig. 3b shows the size of the non-disclosure sets from an ex-ante and an ex-post perspective. The ex-ante non-disclosure set (NDA, see (21)) includes uninformed firms that are not endowed with private information and thus, remain silent as well. Its downward trend resembles Fig. 3a in that the ex-ante expected non-disclosure set shrinks in enforcement intensity, but the increasing number of uninformed firms outside the non-disclosure set attenuates the effect. In contrast, the ex-post non-disclosure set (NDP, see (22)), which further considers the probability of a firm between the compliance threshold v_{com} and the mandatory A to be uncovered by enforcement, increases in enforcement intensity. This originates from the threefold effect that enforcement intensity has on the ex-post non-disclosure set: First, a higher intensity results in a behavioral change, with fewer firms being illegally silent in the first place. Second, a higher intensity leads to a larger share of illegally silent firms being uncovered ex-post. Third, because the behavioral effect dominates the ex-post enforcement effect, fewer firms are uncovered by the more intense enforcement overall. The latter explains why the gap between the size of ex-ante and ex-post non-disclosure sets narrows in enforcement intensity as it simply reflects how many firms that are subject to mandatory reporting and expected to illegally remain silent ex-ante can actually be revealed by enforcement ex-post.

The results illustrated in Fig. 3 offer interesting empirical implications concerning transparency in an economy. The model suggests that overall transparency decreases in enforcement intensity as the size of the non-disclosure set increases. In addition, the model also highlights cross-sectional differences. Consider the disclosure of uncertain liabilities based on their likelihood. Provisions in financial reports represent the related mandatory disclosure, whereas the disclosure of remote, uncertain liabilities in earnings guidance is voluntary. The model predicts that more firms will report provisions in financial reports and fewer firms will report uncertain liabilities in earnings guidance following an increase in enforcement intensity. Moreover, fewer firms should be subject to a restatement related to the reporting of a provision ex-post.

Because transparency focuses on the number and composition of firms revealing their type, we next turn to the capital market effects. Fig. 4a illustrates the pricing from an ex-ante and an ex-post perspective, depicting the voluntary disclosure threshold v_{vol} and the average mispricing (AMP, see (23)) dependent on enforcement intensity. The voluntary disclosure threshold equals the ex-ante non-disclosure price and can be interpreted as a measure of pre-enforcement skepticism toward firms in the non-disclosure set (e.g., Bertomeu et al., 2021b). In contrast, average mispricing is the average absolute difference between the actual firm value and the valuation after the enforcement stage. Both metrics show that pricing issues become less severe following an increase in enforcement intensity, with the non-disclosure price increasing and the average mispricing decreasing in q, respectively. However, the illustration also highlights that the average mispricing can be economically sizable, with mispricing amounting to around five percent of the non-disclosure price in our specification.

Fig. 4b further decomposes average mispricing, highlighting why average mispricing decreases overall, despite that the ex-post non-disclosure set increases in q. Essentially, the decrease in average mispricing of informed, low-value firms with $v < A$ ($AMP_{\Phi=1,v<A}$)—because of the behavioral and ex-post uncovering effect of enforcement—and uninformed firms ($AMP_{\Phi=0}$)—because of the less skeptical non-disclosure price—overcompensates for the increase in average mispricing of high-value firms with $v > A$ ($AMP_{\Phi=1,v>A}$) that increasingly remain silent. As such, the overall effect of an increase in enforcement intensity is positive.



(a) Compliance threshold and ex-post non-disclosure set

(b) Average mispricing

Fig. 5. Extending disclosure regulation.

Empirically, these results suggest that opaque firms should receive a higher average valuation by the capital market and mispricing should on average decrease in enforcement intensity.

Our model also offers additional insights concerning the effect of disclosure regulation on transparency and informational efficiency under differing enforcement regimes. It confirms the conventional wisdom that more extensive disclosure regulation is largely inconsequential absent sufficient enforcement (e.g., Hope, 2003; Holthausen, 2009; Christensen et al., 2013, 2016; Leuz and Wysocki, 2016). Increasing the mandatory threshold A translates into a smaller increase in the number of firms disclosing under the regulation for low compared to high enforcement regimes, as depicted by the respective increase in v^i_{com} in Fig. 5a. However, focusing on mandatory disclosure alone neglects the crowding-out effect that enforcement has on voluntary disclosure, which negatively affects overall transparency.

The effect of a more extensive disclosure regulation on transparency, as depicted by NDP^i, is actually stronger for a low enforcement environment compared to a high enforcement environment. In a low-enforcement environment, high-value firms do not rely on enforcement to separate from non-compliant, low-value firms, but disclose voluntarily. The crowding-out effect on voluntary disclosure is attenuated. In a high-enforcement environment, voluntary disclosure is strongly crowded out, and the effect of more extensive disclosure regulation on overall transparency becomes weaker.

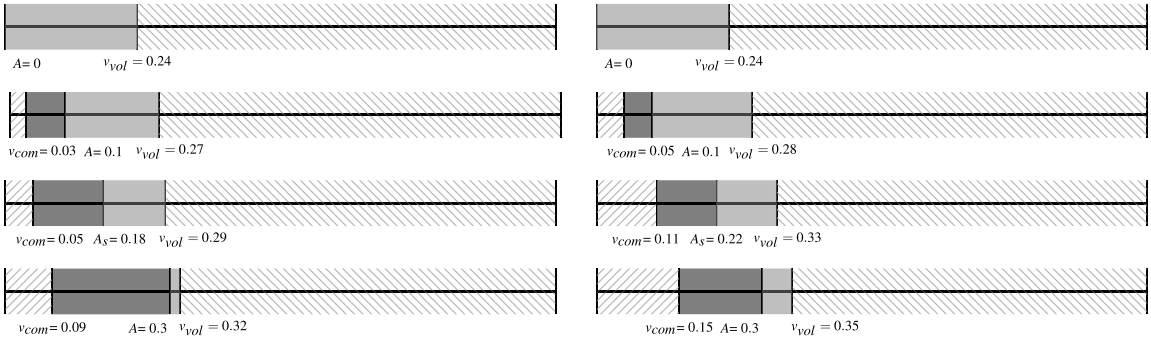
The above transparency effect appears to be at odds with prior empirical findings on the capital market effects of more extensive disclosure regulation. For instance, Christensen et al. (2013) document that expanding disclosure requirements by mandating reporting under International Financial Reporting Standards (IFRS) only provides liquidity benefits in countries with substantive enforcement. Fig. 5b shows the average mispricing in our model and indeed reveals that the effect of a more extensive disclosure regulation is stronger in a high-enforcement environment because it particularly resolves mispricing at the lower end of the value distribution. This effect outweighs the crowding-out effect on voluntary disclosure. While our model results are therefore in line with the observations of related empirical studies, they also highlight that extending mandatory disclosure regulation can be successful in increasing the number of disclosing firms in low-enforcement environments.

3.3. Firms' preferences toward mandatory disclosure

The results concerning the effect of enforcement are so far derived under an exogenous mandatory disclosure threshold. However, firms can also shape disclosure regulation, with enforcement likely affecting firms' attitudes toward the regulation that is subsequently enforced.

Accounting regulation is largely the outcome of a political process (e.g., Sunder, 1988; Zeff, 2005; Königsgruber, 2010). For instance, preparers of financial reports are asked to participate in the standard-setting to (i) increase the acceptance of the standard, (ii) increase the acceptance of the regulator itself, and (iii) ensure transparency over the standard-setting process. These benefits come at the cost of preparers being among the most vocal and powerful groups in expressing opinions (Beresford, 1988; Giner and Arce, 2012). For instance, Zeff (2002) argues that "preparers in the U.S. are well-organized and constitute a powerful lobby." Numerous empirical studies provide evidence on firms applying political pressure when facing changes in accounting regulations (e.g., Lo, 2003; Ramanna, 2008; Hochberg et al., 2009; Jorissen et al., 2012). Thus, firms can try to shape the playing field of their own disclosure choices while taking changes in the enforcement regime into account.

We next determine firms' preferences toward mandatory disclosure regulation using a stylized voting process (e.g., Bertomeu and Cheynel, 2013; Bertomeu and Magee, 2015a,b; Bertomeu et al., 2019). Firms' support or opposition to a mandatory disclosure threshold determines whether a regulation is stable. Assume each firm has equal weight, i.e., can cast one vote, and votes are not publicly observable. As such, we do not attempt to capture all aspects related to firms' exerting political pressure on regulators but



(a) Enforcement intensity $q = 0.8$ **(b)** Enforcement intensity $q = 1$

Fig. 6. Firms' preferences toward mandatory disclosure.

focus on how firms perceive a current disclosure regulation.[12] Given the evolutionary nature of political processes, we further focus on the endogenous mandatory disclosure threshold that is locally stable under a given enforcement regime, i.e., the threshold that is preferred by a majority of voting firms over any candidate in close proximity.[13] Firms that would comply with mandatory disclosure regulation before and after a proposed change are indifferent to any marginal change. They disclose, are priced accordingly, and have no incentives to engage in the political process. The same holds for firms that would disclose voluntarily and separate via means other than mandatory disclosure before and after the proposed change. Thus, the firms in the non-disclosure set determine whether a standard is locally stable or not.

Assume that a marginal increase of the disclosure threshold $A \to A + \varepsilon$ is proposed. Firms with $v_i \in [A + \varepsilon, v_{vol}(A)]$ support the increase as they receive $E(v|ND)$ when remaining silent, which is increasing in A. In contrast, firms with $v_i \in [v_{com}(A + \varepsilon), A]$ face an increasing penalty for a given firm value v_i because $\frac{\partial v_{com}}{\partial A} > 0$. Thus, non-disclosing firms below the threshold A oppose. It follows that a locally stable threshold under a given enforcement regime A_s must be the midpoint of the interval $[v_{com}(A_s), v_{vol}(A_s)]$. In this constellation, both groups cancel each other out so that no standard in close proximity to A_s is preferred by a majority, irrespective of a proposed increase or decrease.

Fig. 6 illustrates the rationale behind the locally stable mandatory threshold A_s and depicts the threshold for two different levels of enforcement intensity q, where Fig. 6a depicts a weaker enforcement regime compared to Fig. 6b. Light (dark) gray areas highlight the supporting (opposing) interest groups. No mandatory disclosure, i.e., $A = 0$, is never locally stable because firms with $v_i \in [\varepsilon, v_{vol}(A = 0)]$ face no opposition against increasing A gradually. However, the opposition by firms with $v_i \in [v_{com}, A]$ grows with the mandatory threshold as the non-compliance threshold increase at a lower rate. Similarly to a zero-disclosure regulation, any threshold leading to an unraveling, i.e., $A \geq A_{crit}$, is never locally stable. There exists at least one firm that would prefer to remain silent and the remaining firms disclose. The following lemma summarizes the finding and provides the locally stable mandatory threshold.

Lemma 3. *The unique locally stable mandatory disclosure threshold A_s under a firm-specific enforcement regime is characterized by an interior threshold $A_s = \frac{1}{2}\left(v_{com}(A_s) + v_{vol}(A_s)\right)$, and given by*

$$A_s = -\frac{1 + \frac{1}{(1+\rho)q}}{\frac{5+8\rho}{2q^2(1+\rho)^3}} \frac{p}{1-p} + \sqrt{\left[\frac{1 + \frac{1}{(1+\rho)q}}{\frac{5+8\rho}{2q^2(1+\rho)^3}} \frac{p}{1-p}\right]^2 + \frac{1}{\frac{5+8\rho}{2q^2(1+\rho)^3}} \frac{p}{(1-p)}}.$$

Proof. See Appendix G. □

Comparing the locally stable thresholds in Fig. 6a and Fig. 6b further reveals the effect of enforcement intensity, and stronger enforcement in general:

Proposition 2. *Firms in economies with stronger enforcement regimes prefer more extensive disclosure regulations. The unique locally stable mandatory disclosure threshold A_s increases in the enforcement intensity q and the litigation strength ρ, respectively.*

Proof. See Appendix H. □

[12] Others, such as Friedman and Heinle (2016), use firms' lobbying efforts toward a regulator to change disclosure regulation. Such lobbying efforts might be publicly observable, which is not the case in our model.

[13] Global stability would require a candidate to be preferred over any possible threshold on the domain, which may result in the consideration of "revolutionary" changes that are rarely observed in reality. Under global stability, a locally stable candidate may be subject to revolutionary cycles and not be stable in the long-run.

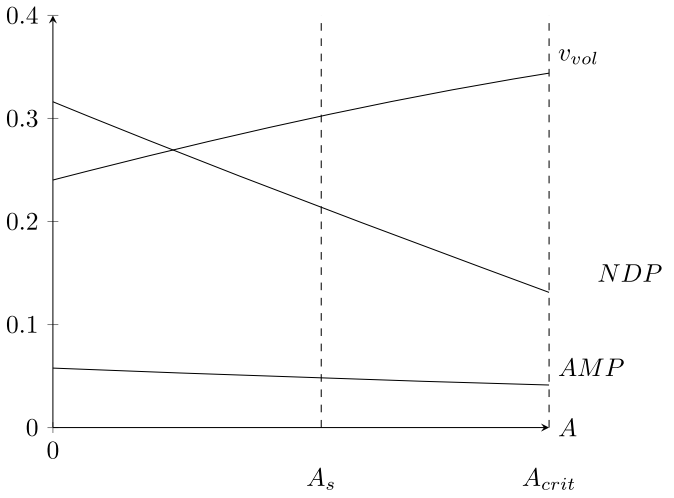


Fig. 7. Locally stable threshold.

More intense enforcement shrinks the set of non-compliant firms. As such, less firms at the bottom of the value distribution oppose the high-value firms that benefit from more disclosure regulation, resulting in an increase of the locally stable mandatory disclosure threshold in equilibrium. The rationale holds analogously when increasing litigation strength via the parameter ρ. As such, this feedback effect, i.e., more enforcement resulting in more firms becoming subject to mandatory disclosure, provides a theoretical explanation for the empirically observed positive relation between enforcement and disclosure regulation (e.g., Christensen et al., 2013; Leuz and Wysocki, 2016). Moreover, countries that bundled enforcement changes with the introduction of more extensive disclosure regulation, such as mandating reporting under IFRS, show positive capital-market effects. While our model results cannot fully speak to the bundling of changes in enforcement and disclosure regulation—because we do not endogenize enforcement—, we document that enforcement changes will lead to positive capital market effects. Firms should be more willing to accept extensive disclosure regulations in countries offering stronger enforcement. The more extensive disclosure regulation in turn results in positive capital-market effects, as shown in Section 3.2.2. Furthermore, enforcement and more extensive disclosure regulation reinforce each other, as capital market effects are stronger in high enforcement regimes.

Fig. 7 illustrates the ex-ante non-disclosure price, the ex-post non-disclosure set, and the average mispricing dependent on A. The locally stable mandatory disclosure threshold A_s does not show a clear relation to either of them. For instance, it follows from the minimum principle that the lowest non-disclosure price minimizes withholding incentives (see Acharya et al., 2011; Guttman et al., 2014; Bertomeu et al., 2021a). However, this is only true without withholding penalties, which is not the case in our model. Further, in a setting with positive disclosure costs, mandatory disclosure of bad news prevents socially inefficient voluntary disclosure. Again, this is not in line with our assumptions, as disclosure costs are zero in our setting. However, both benchmarks speak to the level of transparency, which in our setting implies minimizing the ex-post non-disclosure set. Moreover, minimizing enforcement costs could be another benchmark to evaluate A_s. However, as the compliance threshold is always a fraction of the mandatory disclosure threshold A, this would imply $A = 0$, i.e., no disclosure.

As such, the locally stable, unique mandatory disclosure threshold A_s neither maximizes transparency nor minimizes mispricing. Nevertheless, it has the maximum support of the prepares, which could be a social value on its own. However, it remains debatable whether considering preparers' preferences enhances social welfare or not.

4. Concluding remarks

Building on the theoretical framework of Dye (1985) and Jung and Kwon (1988), we analyze the effects of enforcement on firms' disclosure and their attitude toward mandatory disclosure regulation. We show that disclosure regulation relies on enforcement to ensure appropriate mandatory disclosure practices. However, fostering mandatory disclosure via a centralized solution such as enforcement results in the crowding out of market solutions. Because enforcement incentivizes firms at the lower end of the value distribution to disclose, firms at the upper end of the value distribution have fewer incentives to separate via voluntary disclosure. Stronger enforcement results in fewer firms disclosing overall. However, the capital market effects of enforcement are overall positive. When endogenizing disclosure regulation, fewer firms at the bottom of the value distribution oppose disclosure regulation because stronger enforcement shrinks the set of expected non-compliant firms. As such, our model predicts that firms in economies with stronger enforcement regimes should prefer more extensive disclosure regulations, which again results in the crowding-out of voluntary disclosure but positive overall capital market effects.

Our model also speaks to the empirical literature on enforcement and disclosure. Stronger enforcement not only affects the composition of the set of disclosing firms but reduces the overall disclosure provided in an economy. While our results confirm overall positive capital market effects, empirical research may want to evaluate the effects of the changing types of disclosing firms and identify potential trade-offs for policymakers. Moreover, empirical studies could try to quantify the differential effect of

enforcement intensity and strength identified in our model. While we expect intensity to be more efficient, the economic magnitude and potential implementation costs are crucial. Furthermore, our results confirm a negative relationship between enforcement and common ex-post proxies of reporting quality, such as restatements. The effect of fewer firms illegally remaining silent dominates the effect of more illegally silent firms being uncovered. While we further endogenize disclosure regulation, we do not model other reasons for disclosure regulation, such as information externalities. Overall, our study highlights that more research is needed to guide policymakers on balancing incentives induced by centralized solutions, such as enforcement, and market solutions, such as disclosure.

Declaration of competing interest

The authors declare that they have no known competing financial' interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

Appendix A. List of variables

A	mandatory disclosure threshold, $A \in (0,1)$
A_{crit}	upper bound on A guaranteeing the partial disclosure equilibrium
AMP	average mispricing
D_i	damage resulting from a firm's misreporting
$E[v]$	prior about the firm value
$E[v\|ND]$	non-disclosure price
ND	non-disclosure
NDA	ex-ante non-disclosure set
NDP	ex-post non-disclosure set
p	probability of an uninformed firm, $p \in [0,1]$
v	firm value (random variable)
v_i	(individual) firm value
v_{com}	compliance threshold in the respective regime
v_{vol}	voluntary disclosure threshold in the respective regime
λ_i	expected liability payment for misconduct
ϕ_i,	firm-specific probability of detected misreporting
Φ_i	(individual) status of information endowment, i.e., informed or not informed
ρ	enforcement strength factor, $\rho \geq 1$
q	enforcement intensity factor, $q \in (\frac{1}{2}, 1]$

Appendix B. Proof of Proposition 1

(i) Determine the non-disclosure pooling price $E(v|ND)$ assuming a joint existence of voluntary and mandatory disclosure under firm-specific enforcement.

$$
\begin{aligned}
E(v|ND) = {} & \frac{v_{com}}{2} P(v < v_{com}|ND) + \frac{A + v_{com}}{2} P(v_{com} < v < A|ND, \Phi = \emptyset) \\
& + \frac{A + v_{com}}{2} P(v_{com} < v < A|ND, \Phi = 1, NE) + \frac{A + v_{vol}}{2} P(A < v < v_{vol}|ND) \\
& + \frac{1 + v_{vol}}{2} P(v > v_{vol}|ND) \\
= {} & \Big[\frac{v_{com}}{2} p v_{com} + \frac{A + v_{com}}{2} (A - v_{com}) p + \frac{A + v_{com}}{2} (1 - p) \int_{v_{com}}^{A} \left(1 - q \frac{A - v}{A}\right) dv \\
& + \frac{A + v_{vol}}{2} (v_{vol} - A) + \frac{1 + v_{vol}}{2} (1 - v_{vol}) p \Big] \cdot \Big[p v_{com} + (A - v_{com}) p \\
& + (1 - p) \int_{v_{com}}^{A} \left(1 - q \frac{A - v}{A}\right) dv + (v_{vol} - A) + (1 - v_{vol}) p \Big]^{-1},
\end{aligned} \tag{10}
$$

with $\Phi = 1$ ($\Phi = \emptyset$) indicating (no) information endowment, and NE indicating no enforcement taking place.

(ii) Determine the compliance threshold v_{com} as the firm value $v_i < A$ for which the expected value of remaining silent and getting revealed by enforcement equals the individual firm value.
For firm i with $v_{com} = v_i$, it needs to hold that:

$$\begin{aligned}&(1-\phi_i)E(v|ND)+\phi_i\Big(v_i-\rho\left[E(v|ND)-v_i\right]\Big)=v_i\\&\Leftrightarrow E(v|ND)[1-(1+\rho)\phi_i]=v_i[1-(1+\rho)\phi_i].\end{aligned}\tag{11}$$

For (11) to be satisfied under partial disclosure, it follows $(1-\phi_i-\phi_i\rho)=0 \Leftrightarrow 1-(1+\rho)q\frac{A-v_i}{A}=0 \Leftrightarrow v_i=\left(1-\frac{1}{(1+\rho)q}\right)A=v_{com}$.
Moreover, for $q\in(\frac{1}{2},1]$ and $\rho\geq 1$, it holds that $0<v_{com}\leq A$.
(iii) Determine the voluntary disclosure threshold v_{vol} as the firm value v_i satisfying $E(v|ND)=v_{vol}$.
Rearranging terms and simplifying (10) yields:

$$E(v|ND)=\frac{(1-p)\Big(v_{vol}^2-A^2\Big)+p+(1-p)\Big(A+v_{com}\Big)(1-\alpha)A}{2\Big[(1-p)\Big(v_{vol}-A\Big)+p+(1-p)(1-\alpha)A\Big]},\tag{12}$$

with $v_{com}=\left(1-\frac{1}{(1+\rho)q}\right)A$ and $\int_{v_{com}}^{A}\left(1-q\frac{A-v}{A}\right)dv=\left(\frac{1+2\rho}{2q(1+\rho)^2}\right)A=(1-\alpha)A$.
Setting (12) equal to v_{vol} and transforming terms gives:

$$\begin{aligned}&E(v|ND)=v_{vol}\\&\Leftrightarrow v_{vol}=\alpha A-\frac{p}{1-p}\pm\sqrt{\left[\alpha A-\frac{p}{1-p}\right]^2-\left[A^2-\frac{p}{1-p}-(A+v_{com})(1-\alpha)A\right]}.\end{aligned}\tag{13}$$

As $\alpha<1$, only adding the square root can result in $v_{vol}>A$. It follows:

$$\Leftrightarrow v_{vol}=\alpha A-\frac{p}{1-p}+\sqrt{\left[\alpha A-\frac{p}{1-p}\right]^2-\left[\beta A^2-\frac{p}{1-p}\right]},\tag{14}$$

with $\alpha=\left(1-\frac{1+2\rho}{2q(1+\rho)^2}\right)$ and $\beta=\left(1-\frac{(1+2\rho)(2q(1+\rho)-1)}{2q^2(1+\rho)^3}\right)$. □

Appendix C. Proof of Lemma 1

For $A<v_{vol}$, simplifying (14) by $\alpha=\left(1-\frac{1+2\rho}{2q(1+\rho)^2}\right)$ and $\beta=\left(1-\frac{(1+2\rho)[2q(1+\rho)-1]}{2q^2(1+\rho)^3}\right)$, it follows:

$$\begin{aligned}&\alpha A-\frac{p}{1-p}+\sqrt{\left[\alpha A-\frac{p}{1-p}\right]^2-\left[\beta A^2-\frac{p}{1-p}\right]}>A\\&\Leftrightarrow A^2+A\frac{p}{1-p}\frac{2}{(1-2\alpha+\beta)}-\frac{p}{1-p}\frac{1}{(1-2\alpha+\beta)}<0\end{aligned}$$

Solving for the critical value of A results in two candidates:

$$A_{1/2}=-\frac{p}{(1-p)}\frac{1}{(1-2\alpha+\beta)}\pm\sqrt{\left[\frac{p}{(1-p)}\frac{1}{(1-2\alpha+\beta)}\right]^2+\frac{p}{(1-p)}\frac{1}{(1-2\alpha+\beta)}}$$

As the first term is always negative, the upper bound of A is:

$$A_{crit}=-\frac{p}{(1-p)}\frac{1}{(1-2\alpha+\beta)}+\sqrt{\left[\frac{p}{(1-p)}\frac{1}{(1-2\alpha+\beta)}\right]^2+\frac{p}{(1-p)}\frac{1}{(1-2\alpha+\beta)}}.\tag{15}$$

Moreover, it needs to hold that $A_{crit}<E(v)=\frac{1}{2},\forall p\in(0,1)$. Otherwise, all informed firms would disclose. Using (15), it follows:

$$\begin{aligned}&-\frac{p}{(1-p)}\frac{1}{(1-2\alpha+\beta)}+\sqrt{\left[\frac{p}{(1-p)}\frac{1}{(1-2\alpha+\beta)}\right]^2+\frac{p}{(1-p)}\frac{1}{(1-2\alpha+\beta)}}<\frac{1}{2}\\&\left[\frac{p}{(1-p)}\frac{1}{(1-2\alpha+\beta)}\right]^2+\frac{p}{(1-p)}\frac{1}{(1-2\alpha+\beta)}<\frac{1}{4}+\frac{p}{(1-p)}\frac{1}{(1-2\alpha+\beta)}+\left[\frac{p}{(1-p)}\frac{1}{(1-2\alpha+\beta)}\right]^2\\&0<\frac{1}{4}.\end{aligned}$$

For $q\in(\frac{1}{2},1]$, $\rho\geq 1$, and $p\in[0,1]$, a partial disclosure equilibrium characterized by $0<v_{com}<A<v_{vol}<1$ exists iff $A<A_{crit}$. □

Appendix D. Verrecchia-type disclosure cost friction

(i) Determine the non-disclosure pooling price $E(v|ND)$ assuming a joint existence of costly voluntary and mandatory disclosure under firm-specific enforcement.

$$\begin{aligned} E(v|ND) &= \frac{A+v_{com}}{2} P(v_{com} < v < A|NE) + \frac{A+v_{vol}}{2} P(A < v < v_{vol}) \\ &= \frac{\frac{A+v_{com}}{2} \int_{v_{com}}^{A} \left(1 - q\frac{A-v}{A}\right) dv + \frac{A+v_{vol}}{2}(v_{vol} - A)}{v_{vol} - v_{com}} \\ &= \frac{\frac{A^2 - v_{com}^2}{2}(1-q) + q\frac{(A+v_{com})(A-v_{com}^2)}{4A} + \frac{v_{vol}^2 - A^2}{2}}{v_{vol} - v_{com}}, \end{aligned} \tag{16}$$

with NE indicating no enforcement taking place.

(ii) Determine the compliance threshold v_{com} as the firm value $v_i < A$ for which the expected value of remaining silent and getting revealed by enforcement equals the individual firm value.

For firm i with $v_{com} = v_i$, it needs to hold that:

$$\begin{aligned} &(1-\phi_i)E(v|ND) + \phi_i\Big((v_i - c) - \rho\big[E(v|ND) - (v_i - c)\big]\Big) = v_i - c \\ &\Leftrightarrow E(v|ND)[1 - (1+\rho)\phi_i] = (v_i - c)\left[1 - (1+\rho)\phi_i\right]. \end{aligned} \tag{17}$$

For (17) to be satisfied under partial disclosure, it follows $(1 - \phi_i - \phi_i\rho) = 0 \Leftrightarrow 1 - (1+\rho)q\frac{A-v_i}{A} = 0 \Leftrightarrow v_i = \left(1 - \frac{1}{(1+\rho)q}\right)A = v_{com}$. Moreover, for $q \in (\frac{1}{2}, 1]$ and $\rho \geq 1$, it holds that $0 < v_{com} \leq A$.

(iii) Determine the voluntary disclosure threshold v_{vol} as the firm value v_i satisfying $E(v|ND) = v_{vol} - c$.

Setting (16) equal to $(v_{vol} - c)$ and transforming terms gives:

$$\begin{aligned} &E(v|ND) = (v_{vol} - c) \\ &\Leftrightarrow v_{vol} = (v_{com} + c) + \sqrt{c^2 - qA^2 + \frac{q}{2}\left(A + v_{com} + v_{com}^2 - \frac{v_{com}^3}{A}\right)}. \end{aligned} \tag{18}$$

Assuming $A < A_{crit}(c)$, only adding the square root results in $v_{com} < A < v_{vol}$.

To show existence, consider $q = \rho = 1$, $c = 0.2$, and $A = 0.3$, it follows that $v_{com} = 0.15$, $v_{vol} = 0.775$, and $E[v|ND] = 0.575$, with $A_{crit} = 1/19 \cdot (12 + 16c)$. □

Appendix E. Differential impact on compliance

$$\frac{\partial v_{com}}{\partial q} = \frac{A}{q^2(1+\rho)} > 0 \tag{19}$$

$$\frac{\partial v_{com}}{\partial \rho} = \frac{A}{q(1+\rho)^2} > 0 \tag{20}$$

Comparing the two derivatives results in:

$$\begin{aligned} \frac{A}{q^2(1+\rho)} &> \frac{A}{q(1+\rho)^2} \\ \frac{1}{q} &> \frac{1}{(1+\rho)} \\ (1+\rho) &> q. \end{aligned}$$

For $q \in (\frac{1}{2}, 1]$ and $\rho \geq 1$, the above always holds s.t. $\frac{\partial v_{com}}{\partial q} > \frac{\partial v_{com}}{\partial \rho}$. □

Appendix F. Transparency and average mispricing metrics

Ex-ante non-disclosure set

Let NDA be the size of the ex-ante non-disclosure set before the enforcement stage. It covers uninformed firms below the compliance threshold, informed and uninformed firms between the compliance threshold and the voluntary disclosure threshold, and uninformed firms above the voluntary disclosure threshold:

$$\begin{aligned} NDA &= pv_{com} + (v_{vol} - v_{com}) + p(1 - v_{vol}) \\ &= \frac{(1-p)\left[A + q(1+\rho)^2\sqrt{-\frac{A^2(1+2\rho)}{q^2(1+\rho)^4} + \frac{4p(1+\frac{A(1-\rho)(1+2\rho-2q(1+\rho)^2)}{q(1+\rho)^2})}{(1-p)^2}}\right]}{2q(1+\rho)^2}. \end{aligned} \tag{21}$$

Ex-post non-disclosure set

Let NDP measure the size of the ex-post non-disclosure set after the enforcement stage. It covers uninformed firms below the mandatory disclosure threshold, informed firms that remain silent illegally and are not uncovered, informed and uninformed firms between the mandatory and the voluntary disclosure threshold, and uninformed firms above the voluntary disclosure threshold:

$$\begin{aligned} NDP &= pv_{com} + p(A - v_{com}) + (1-p)(A - v_{com}) \int_{v_{com}}^{A} 1 - q\frac{A-v}{A}\,dv + (v_{vol} - A) + p(1 - v_{vol}) \\ &= \frac{(1-p)\left[A^2(1+2\rho) - Aq(1+3\rho+2\rho^2) + q^2(1+\rho)^3\sqrt{-\frac{A^2(1+2\rho)}{q^2(1+\rho)^4} + \frac{4p\left(1+\frac{(A(1-\rho)(1+2\rho-2q(1+\rho)^2)}{q(1+\rho)^2}\right)}{(1-p)^2}}\right]}{2q^2(1+\rho)^3}. \end{aligned} \tag{22}$$

Average mispricing

Let AMP denote the average mispricing in the economy. It covers mispricing of uninformed firms, informed firms between the mandatory and the voluntary disclosure threshold, and informed firms that remain silent illegally and are not uncovered:

$$\begin{aligned} AMP &= pv_{vol}\frac{v_{vol}}{2} + p(1 - v_{vol})\frac{1 - v_{vol}}{2} \\ &\quad + (1-p)\frac{(v_{vol} - A)^2}{2} + \\ &\quad + (1-p)\left[\int_{v_{com}}^{A}\left(1 - q\frac{A-v}{A}\right)(v_{vol} - v)\,dv\right] \\ &= p(v_{vol}^2 - v_{vol} + \frac{1}{2}) + (1-p)\frac{(v_{vol} - A)^2}{2} \\ &\quad + (1-p)\left[v_{vol}\frac{1+2\rho}{2q(1+\rho)^2}A - A^2\left(\frac{(1-q)(1-\alpha^2)}{2} + \frac{q(1-\alpha^3)}{3}\right)\right]. \end{aligned} \tag{23}$$

Derivatives

For $\rho = 1$ and $p = 0.1$, the first-order derivatives of the ex-post non-disclosure set and average mispricing in Section 3 are:

$$\frac{\partial NDP}{\partial q} = \frac{A(243A - 216q) + 27A\gamma(A - q)}{80q^3\gamma} > 0, \tag{24}$$

and

$$\frac{\partial AMP}{\partial q} = \frac{1296A^3(4q-3) + Aq^2(10240 - 704\gamma)}{7680q^4\gamma} \tag{25}$$

$$+ \frac{9A^2q\left[(47\gamma - 64) + q(10\gamma - 1536)\right]}{7680q^4\gamma} < 0, \tag{26}$$

with $\gamma = \sqrt{640 - \frac{243A^2 + Aq(1152q - 432)}{q^2}}$.

Appendix G. Proof of Lemma 3

Requiring equally large sets of opposing and supporting firms implies:

$$\begin{aligned} A_s &= \frac{v_{vol}(A_s) + v_{com}(A_s)}{2} \\ \Leftrightarrow\ A_s &= \frac{A_s}{2}\left[1 - \frac{1}{(1+\rho)q}\right] + \frac{1}{2}\left[\alpha A_s - \frac{p}{1-p} + \sqrt{\left[\alpha A_s - \frac{p}{1-p}\right]^2 - \left[\beta A_s^2 - \frac{p}{1-p}\right]}\right] \end{aligned}$$

$$\Leftrightarrow A_s\left[1+\frac{1}{(1+\rho)q}-\alpha\right]+\frac{p}{1-p}=\sqrt{\left[\alpha A_s-\frac{p}{1-p}\right]^2-\left[\beta A_s^2-\frac{p}{1-p}\right]}$$

$$\Leftrightarrow A_s^2+2A_s\frac{1+\frac{1}{(1+\rho)q}}{\left[(1-2\alpha+\beta)+\frac{1+(1-\alpha)2q(1+\rho)}{q^2(1+\rho)^2}\right]}\frac{p}{1-p}-\frac{1}{\left[(1-2\alpha+\beta)+\frac{1+(1-\alpha)2q(1+\rho)}{q^2(1+\rho)^2}\right]}\frac{p}{1-p}=0$$

Substituting $\alpha=\left(1-\frac{1+2\rho}{2q(1+\rho)^2}\right)$ and $\beta=\left(1-\frac{(1+2\rho)[2q(1+\rho)-1]}{2q^2(1+\rho)^3}\right)$, and simplifying terms, yields:

$$\Leftrightarrow A_s=-\frac{1+\frac{1}{(1+\rho)q}}{\frac{5+8\rho}{2q^2(1+\rho)^3}}\frac{p}{1-p}\pm\sqrt{\left[\frac{1+\frac{1}{(1+\rho)q}}{\frac{5+8\rho}{2q^2(1+\rho)^3}}\frac{p}{1-p}\right]^2+\frac{1}{\frac{5+8\rho}{2q^2(1+\rho)^3}}\frac{p}{(1-p)}}$$

As only adding the square root can result in a positive A_s, it follows that the locally stable mandatory disclosure threshold is given by:

$$A_s=-\frac{1+\frac{1}{(1+\rho)q}}{\frac{5+8\rho}{2q^2(1+\rho)^3}}\frac{p}{1-p}+\sqrt{\left[\frac{1+\frac{1}{(1+\rho)q}}{\frac{5+8\rho}{2q^2(1+\rho)^3}}\frac{p}{1-p}\right]^2+\frac{1}{\frac{5+8\rho}{2q^2(1+\rho)^3}}\frac{p}{(1-p)}}.\quad\square \tag{27}$$

Appendix H. Proof of Proposition 2

Rewriting (27) yields:

$$A_s=-h(q,\rho,p)+\sqrt{h^2(q,\rho,p)+2j(q,\rho,p)} \tag{28}$$

For the first-order derivatives with respect to q, ρ, or p, as indicated by $'$, it follows:

$$A_s'=-h'+\frac{1}{2\sqrt{h^2+2j}}\left[h^{2'}+2j'\right]=h'\left[\frac{h}{\sqrt{h^2+2j}}-1\right]+j'\frac{1}{\sqrt{h^2+2j}}$$

For $A_s'>0$, it needs to hold:

$$h'\left[\frac{h}{\sqrt{h^2+2j}}-1\right]+j'\frac{1}{\sqrt{h^2+2j}}>0$$
$$\Leftrightarrow j'\frac{1}{\sqrt{h^2+2j}}>h'\left[1-\frac{h}{\sqrt{h^2+2j}}\right]$$
$$\Leftrightarrow j'>h'\left[-h+\sqrt{h^2+2j}-h\right]$$
$$\Leftrightarrow \frac{j'}{h'}>-h+\sqrt{h^2+2j}$$
$$\Leftrightarrow \frac{j'}{h'}>A_s,$$

given $j'>0$ and $h'>0$ (see, (31), (32), (34), and (35)).
Substituting A_s by $-h+\sqrt{h^2+2j}$ and $\frac{j'}{h'}$ by ε, and considering $h=2j\left(1+\frac{1}{(1+\rho)q}\right)$, yields:

$$\varepsilon>-h+\sqrt{h^2+2j}$$
$$\Leftrightarrow \varepsilon+h>\sqrt{h^2+2j}$$
$$\Leftrightarrow \varepsilon^2+2\varepsilon h+h^2>h^2+2j$$
$$\Leftrightarrow \varepsilon^2+2\varepsilon\left(1+\frac{1}{(1+\rho)q}\right)2j>\frac{2\varepsilon}{2\varepsilon}2j$$
$$\Leftrightarrow \varepsilon^2+4\varepsilon j\left(1+\frac{1}{(1+\rho)q}-\frac{1}{2\varepsilon}\right)2j>0. \tag{29}$$

For (29) to be fulfilled, it is sufficient to show that for a respective ε:

$$\left(1+\frac{1}{(1+\rho)q}-\frac{1}{2\varepsilon}\right)>0. \tag{30}$$

Enforcement intensity

$$\frac{\partial h(q,\rho,p)}{\partial q}=\frac{2(1+\rho)^2+4q(1+\rho)^3}{5+8\rho}\frac{p}{1-p}>0 \tag{31}$$

$$\frac{\partial j(q,\rho,p)}{\partial q} = \frac{2q(1+\rho)^3}{5+8\rho}\,\frac{p}{1-p} > 0 \tag{32}$$

$$\varepsilon = \frac{q(1+\rho)}{1+2q(1+\rho)} > 0 \tag{33}$$

From (30), it yields:

$$\begin{aligned} &\left(1+\frac{1}{(1+\rho)q}-\frac{1}{2\varepsilon}\right) > 0 \\ \Leftrightarrow &\left(1+\frac{1}{(1+\rho)q}-\frac{1+2q(1+\rho)}{2q(1+\rho)}\right) > 0 \\ \Leftrightarrow &\frac{1}{2q(1+\rho)} > 0 \end{aligned}$$

For $q \in (\frac{1}{2}, 1]$, $\rho \geq 1$, and $p \in [0,1]$, $\frac{\partial A_s}{\partial q} > 0$ follows. □

Enforcement strength

$$\frac{\partial h(q,\rho,p)}{\partial \rho} = \frac{2q(1+\rho)\left[q(16\rho^2+23\rho+7)+8\rho+2\right]}{(5+8\rho)^2}\,\frac{p}{1-p} > 0 \tag{34}$$

$$\frac{\partial j(q,\rho,p)}{\partial \rho} = \frac{q^2(16\rho+7)(1+\rho)^2}{(5+8\rho)^2}\,\frac{p}{1-p} > 0 \tag{35}$$

$$\varepsilon = \frac{q(16\rho+7)(1+\rho)}{2q(16\rho^2+23\rho+7)+16\rho+4} > 0 \tag{36}$$

From (30), it yields:

$$\begin{aligned} &\left(1+\frac{1}{(1+\rho)q}-\frac{1}{2\varepsilon}\right) > 0 \\ \Leftrightarrow &\left(1+\frac{1}{(1+\rho)q}-\frac{2q(16\rho^2+23\rho+7)+16\rho+4}{2q(16\rho+7)(1+\rho)}\right) > 0 \\ \Leftrightarrow &\frac{48\rho+18}{2q(16\rho+7)(1+\rho)} > 0 \end{aligned}$$

For $q \in (\frac{1}{2}, 1]$, $\rho \geq 1$, and $p \in [0,1]$, $\frac{\partial A_s}{\partial \rho} > 0$ follows. □

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