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Economic effects of litigation risk on corporate disclosure and innovation

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Abstract
Empirical studies on the relationship between shareholder litigation and corporate disclosure obtain mixed results. We develop an economic model to capture the endogeneity between disclosure and litigation. Equilibrium disclosure is determined by two countervailing effects of litigation, a deterrence effect and an insurance effect. We derive four key results. (i) Decreasing litigation risk leads to less disclosure of very bad news, due to a weakening of the deterrence effect, but to more disclosure of weakly bad news, due to a weakening of the insurance effect. (ii) Given a sufficiently large information asymmetry, litigation risk dampens (boosts) overall disclosure of bad news for low (high) litigation risk firms. (iii) Capital markets respond more to the disclosure of bad news than of good news if the deterrence effect is strong, which arises if both insiders' penalties and litigation risk are high. (iv) In an extension, we highlight real effects of litigation on corporate innovation and establish that innovation first decreases and then increases (strictly decreases) with litigation risk if insiders' penalties are small (large). We reconcile our findings with results from a large set of U.S.-based empirical studies and make several novel predictions.

Keywords Private litigation · Litigation risk · Corporate disclosure · Corporate innovation

JEL classification: G18 · K22 · K41 · K42 · M41 · M48

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1 Introduction

The effect of litigation risk on corporate disclosure is a contentious issue in accounting research. While some empirical studies find evidence of a negative association (e.g., Johnson et al. 2001; Baginski et al. 2002; Bourveau et al. 2018), others provide evidence of a positive one (e.g., Houston et al. 2019; Naughton et al. 2019; Huang et al. 2020). Among the most common arguments for a positive relationship is the litigation-prevention argument, popularized by Skinner (1994). According to this argument, insiders observing bad news anticipate that withholding their information may trigger litigation and private penalties if bad news is later revealed (e.g., in an earnings announcement). These penalties represent, for instance, unfavorable career outcomes (Humphery-Jenner 2012; Brochet and Srinivasan 2014; Ali et al. 2019) rather than the direct costs of litigation (Klausner et al. 2013). To prevent litigation and penalties, insiders disclose their information as long as the expected penalties outweigh the marginal pricing benefit of withholding. This argument comports with a *deterrence effect*, as first identified by Becker (1968).[1]

While the litigation-prevention argument focuses on managerial decision-making, the empirical disclosure literature so far has not considered the effects of litigation rights on investor decision-making. In contrast, the theoretical accounting literature studies the effects of litigation on both insiders *and* investors, especially in the context of misreporting and auditing (Schwartz 1997; Hillegeist 1999; Laux and Stocken 2012). The argument here is that endowing privately uninformed investors with litigation rights insures them against harm from strategic public information distortions. The expectation of the possibility of damage compensation alleviates their price protective behavior, increasing their willingness to pay a higher price. Litigation rights thus establish an *insurance effect,* consistent with the work of Arrow (1965).[2] Due to this effect, a higher price encourages distortion of information by managers. Contrary to the misreporting and auditing literature, the disclosure literature has considered settings in which the deterrence and insurance effects of litigation rights arise in isolation (Trueman 1997; Dye 2017). In contrast, we develop a model in which both arise simultaneously. This enables us to characterize explicit conditions under which one dominates the other, which helps explain the mixed empirical evidence on the relation between litigation and disclosure.

Our model builds on a standard voluntary disclosure model with an uncertain information endowment of an insider (Dye 1985; Jung and Kwon 1988). The insider is an entrepreneur who sells her firm to investors in a perfectly competitive capital market. The entrepreneur potentially holds proprietary information and decides whether to disclose it. Investors consider the disclosure or the fact that there was no disclosure

[1] An alternative argument may be that managers withhold bad news to avoid triggering litigation (e.g., Francis et al. 1994). We do not consider this argument further, as we assume that managers cannot withhold bad news indefinitely.

[2] The insurance effect arising from shareholder litigation rights should not be confused with the standard practice of companies purchasing D&O litigation insurance. While the former concerns an economic effect of litigation rights per se, the latter represents firms' response to litigation in that they purchase litigation insurance to cover their costs in the event of a lawsuit. Litigation insurance can be shown to give rise to other economic effects. See, e.g., Caskey (2013).

and price protect against expected losses arising from potential information asymmetries in the event of nondisclosure. We augment this standard model by introducing the possibility of strategic litigation, which reflects several institutional realities. (i) Litigation is triggered by later public information that suggests that investors might have overpaid and therefore have a legal claim.[3] (ii) Litigation is initiated by an attorney who bears such costs as filing fees and preparation costs for bringing a lawsuit (Eisenberg and Miller 2010) and who receives an equity stake in the lawsuit as compensation from investors.[4] (iii) During a lawsuit, the court learns whether the entrepreneur was informed. (iv) If the entrepreneur is found to have withheld information, both plaintiff investors and the attorney receive compensation, where the compensation is as a function of investors' losses (Cox et al. 2005). (v) Damage compensation is entirely covered by litigation insurance. (vi) The entrepreneur does not privately contribute to the compensation but incurs a private penalty imposed by, for instance, labor markets.[5]

We solve for the rational expectations equilibrium in this model and highlight several interesting equilibrium properties.[6] As in the Dye (1985) and Jung and Kwon (1988) model, the entrepreneur has the incentive to disclose sufficiently favorable information. When compared with the price before disclosure, sufficiently favorable information includes all good news (i.e., disclosures that yield a positive market reaction) and weakly bad news (i.e., disclosures that yield a weakly negative market reaction). Upon later revelation of plausibly withheld bad news, investors approach an attorney, who decides whether to sue on their behalf. The attorney's decision trades off his conditionally expected compensation from a successful lawsuit and the fixed cost of bringing the case. Since the expected compensation depends on investors' losses, the attorney rationally considers litigation only for sufficiently large losses and thus for very bad news.

The entrepreneur anticipates the attorney's decision and reassesses whether withholding bad news is still beneficial, considering the penalty in case of litigation. For intermediately bad news for which the attorney would not rationally sue, there is no risk of a penalty, and the entrepreneur continues to withhold. In contrast, for very but not extremely bad news for which the marginal pricing benefit of withholding does not exceed the penalty, the entrepreneur discloses. Thus, for very bad news, the deterrence effect becomes effective and acts as an out-of-equilibrium threat that induces disclosure. However, for extremely bad news, the entrepreneur withholds again, as the utility from price manipulation outweighs the penalty. The attorney anticipates

[3] Studies document that litigation is triggered by various fundamental information events, ranging from earnings announcements (Skinner 1997; Donelson et al. 2012) to large market downturns (Donelson and Hopkins 2016).

[4] This is consistent with Coffee (2015) observation that modern class action litigation is entrepreneurial in nature, as attorneys advance their expenses under the prospect of receiving a share of the settlement while bearing the risk of absorbing the costs if litigation fails.

[5] Features (v) and (vi) are broadly consistent with the evidence of Klausner et al. (2013), who study a sample of U.S. securities class action settlements between 2006 and 2012. They find that D&O insurance fully pays in 58% of cases and partially pays in 28%. In addition, they document that individual officers and directors do not contribute to settlements in 98% of cases.

[6] In the formal analysis, we show that there exist three cases, depending on the magnitude of the entrepreneur's penalty. In the following discussion, we focus on the most realistic case with intermediate penalties.

this disclosure strategy and only sues for extremely bad news. Overall the equilibrium features two disjoint disclosure sets and two disjoint nondisclosure sets.

Upon nondisclosure, investors price the firm not only at its conditionally expected cash flow but also consider the compensation they might receive if they successfully sue. The additional utility they expect leads them to relax their price protection and induces a higher nondisclosure price. The entrepreneur anticipates this effect and alters her basic disclosure strategy by *withholding* some weakly bad news. Consequently, while litigation risk leads to the disclosure of very bad news (the deterrence effect), it also leads to the withholding of some weakly bad news (the insurance effect).

We also show how changes in litigation risk impact the relative strength of the two effects. The attorney's legal cost captures both actual and perceived litigation risk, as a larger cost implies fewer bad news realizations for which the attorney would rationally litigate. Consequently, an increase in this cost implies a decrease of litigation risk, weakening both economic effects of litigation rights.[7] We derive necessary conditions for which the change in one effect unambiguously dominates the change in the other. In particular, the deterrence effect is particularly strong for firms *either* experiencing relatively low levels of information asymmetry *or* facing relatively large litigation risk, whereas the insurance effect is particularly strong for firms facing large information asymmetry *and* small litigation risk.

Equipped with these results, we perform additional analyses. Empirical disclosure studies compare the average market reactions to good news and bad news disclosures to infer disclosure incentives. This approach was championed by Skinner (1994), who documents a stronger average market response to bad news than to good news, which he interprets as evidence of the threat of litigation encouraging the disclosure of bad news. However, he also documents that bad news tends to be conveyed qualitatively, whereas good news tends to be disclosed quantitatively. This is puzzling, as, all else equal, more precise disclosures should yield stronger market responses, in contrast to the asymmetric market responses result.

We formally derive the average magnitudes of the market reactions to good and bad news disclosures and find that a stronger reaction to bad news arises only if both the entrepreneur's penalty and litigation risk are sufficiently high. Intuitively, while the entrepreneur discloses all good news, for the *average* bad news disclosure to induce a stronger market reaction, enough very and extremely bad news must be disclosed, while enough weakly and intermediately bad news must be withheld. Such a disclosure pattern occurs only if the deterrence effect is sufficiently strong, which is the case under the obtained conditions. In this regard, our results complement those of Trueman (1997), who endogenizes the disclosure precision choice and finds less accurate disclosure of bad than of good news. However, he does not compare the average market reactions. Holding the disclosure precision constant, we describe the disclosure pattern that leads to the empirical regularity, which provides a partial reconciliation of the seemingly contradictory evidence of Skinner (1994).

[7] Particularly in the United States, it is often argued that litigation risk is too high, and there have been several regulatory attempts to reduce it. Recent empirical studies utilize, in their empirical designs, these regulatory events, including the Private Securities Litigation Reform Act (PSLRA) in 1995 or the Universal Demand (UD) laws between 1998 and 2005. To align our predictions with theirs, we adopt the convention of stating our results in terms of decreasing litigation risk throughout the paper.

Note too that the inference drawn from the regularity of asymmetric market reactions differs across empirical studies. For instance, Kothari et al. (2009) show that the pattern is due to firms being more likely to disclose good news. Our analysis suggests that the different inferences drawn by Skinner (1994) and Kothari et al. (2009) are not mutually exclusive but instead rely on each other: litigation can give rise to disclosure of very bad news, but disclosure of good news is still more likely than of bad news, as some intermediately bad news must be withheld for the regularity to arise.

Finally, we extend our model to study whether and how litigation risk affects real decision-making. We focus on a specific real decision, namely entrepreneurial innovative incentives. Corporate innovation helps drive macroeconomic growth and therefore matters to regulators, who aim to create a pro-growth environment (Arrow 1962; Stockey 1995). There are concerns in the business community that litigation discourages innovation. For example, in a congressional hearing in the 1990s, the president of Silicon Graphics, Edward McCracken, referred to shareholder litigation as an "*uncontrolled tax on innovation*" that is "*impacting real creation of jobs*" (Seligman 1994). Recent evidence by Lin et al. (2021) supports this notion.

We introduce innovation by assuming that the entrepreneur exerts effort that increases the probability that the fundamental cash flow stream we focus on in the disclosure game arises (Laux and Stocken 2018). We show that, counter to public concerns, shareholder litigation can improve innovation incentives under certain conditions. This nuanced result stems from the two countervailing effects of litigation rights. The threat of penalties not only deters the strategic withholding of information but can also stifle innovation incentives. However, higher expected prices, due to the insurance effect, encourage innovation. We show that the baseline level of litigation risk itself can determine the relative dominance of one effect over the other. In particular, given small enough insider penalties, innovation first decreases and then increases in litigation risk. In contrast, innovation unambiguously decreases in litigation risk for large enough penalties.

Overall our model establishes an endogenous association between corporate disclosure and shareholder litigation in which, different from prior theoretical work, the deterrence and insurance effects of litigation can arise simultaneously. This enables us to formally reconcile a large set of empirical regularities and arguments on the disclosure-litigation association. In addition, we derive novel theoretical results and refined predictions on this association as well as on the real effects of shareholder litigation for corporate innovation.

2 Literature review

Our paper relates to the literature on the economic effects of private litigation for the strategic distortion of firms' public information environments. A first subset of studies concerns misreporting of mandatorily reported information with a focus on auditing incentives. Dye (1993) establishes that the prospect of liability for audit failures disciplines auditors and motivates them to exert effort. Schwartz (1997) studies an auditing setting in which an auditor can be held liable by investors for damages arising from audit failure and liability can take the form of negligence or strict liability. Following Dye (1993), the threat of litigation then incentivizes the auditor to exert effort. Under a negligence liability regime, the investor further anticipates a reimbursement of investment losses from audit failures when making investment decisions, leading to overinvestment. Hillegeist (1999) endogenizes the misreporting incentives of audited firms' insiders and considers competitive capital market pricing. He studies different damage apportionment rules, which define how much auditors and owners must pay if the other party cannot pay its share of the damages to investors. He finds that investors price the value of their future legal claim, leading to higher prices. Since the insider aims to maximize the short-term stock price, the insider's misreporting incentives increase with the investors' legal claim.

A second set of studies focuses on insiders' misreporting incentives without considering auditing. Evans and Sridhar (2002) consider a binary setting with misreporting by a capital market-oriented manager in the presence of a product market entry threat by a rival that introduces proprietary costs in the spirit of Verrecchia (1983) and Wagenhofer (1990). They show that product markets and capital markets induce opposing incentives to misreport private information and that shareholder litigation, with a pricing effect similar to the one offered by Hillegeist (1999), can induce under- or overreporting in an equilibrium with mixed strategies.[8] Laux and Stocken (2012) consider misreporting by an insider in the presence of litigation and find that, if the insider is overoptimistic, litigation can increase or decrease misreporting incentives. It increases incentives, due to the pricing effect of Hillegeist (1999), and alleviates them, due to the private costs incurred by the insider. They further characterize conditions under which litigation increases misreporting incentives, which occurs if recoverable damages are large or the insider is very optimistic. Schantl and Wagenhofer (2020) study an insider who benefits from upward misreporting and privately incurs penalties if either strategic public enforcement or strategic private litigation uncover manipulation. They find that public enforcement crowds out private litigation and weakens misreporting deterrence in strong private litigation regimes. Overall these studies feature either or both of the deterrence effect or the insurance effect of litigation rights in misreporting or auditing settings.

We are aware of only two studies, by Trueman (1997) and Dye (2017), that formally consider the deterrence and insurance effects of litigation in disclosure settings. Both use a variant of the standard disclosure framework with uncertain information endowment of an insider (Dye 1985; Jung and Kwon 1988). Trueman (1997) uses a variant of this model with discrete fundamentals and introduces a rent-seeking attorney who litigates in case unfavorable information is revealed. He assumes that the attorney extracts the entire rent associated with litigation but also bears all costs. Trueman (1997) finds that the firm discloses sufficiently favorable and very unfavorable information while withholding intermediate information.[9] Dye (2017) considers a setting with continuous fundamental information and studies the disclosure behavior of an insider when a fact finder may later discover that the insider withheld information. He

[8] Marinovic and Varas (2016) find a similar result in a dynamic binary voluntary disclosure model with costless litigation.

[9] Bertomeu et al. (2021) offer a different argument for such a disclosure strategy, based on voluntary (favorable) and mandatory (very unfavorable) disclosure, where the mandatory disclosure arises from the desire of a standard setter to limit excessive voluntary disclosures and thus to save on direct disclosure costs.

assumes that the insider compensates investors for a part of their losses in the event of litigation. Since the costs associated with litigation are small, litigation does not directly affect disclosure, so that the insider only discloses sufficiently favorable information. Yet the prospect of damage compensation affects investors in that they price it upon nondisclosure. This increases the nondisclosure price, leading to less disclosure. In other words, Trueman (1997) assumes away the insurance effect of litigation, since the attorney is the sole beneficiary of litigation, whereas Dye (2017) implicitly assumes that the costs of litigation incurred by the insider are small, effectively muting the deterrence effect.

The equilibria characterized by Trueman (1997) and Dye (2017) arise as special cases in our model. Importantly, we identify conditions under which both effects of litigation arise simultaneously and derive additional conditions under which one effect dominates the other in determining the impact of litigation risk on overall disclosure, where this contributes to explaining the mixed evidence in the empirical disclosure literature. A key feature of our model further is that, like Trueman (1997), Evans and Sridhar (2002), and Schantl and Wagenhofer (2020) but different from Dye (1993), Schwartz (1997), and Laux and Stocken (2012), we consider litigation as an endogenous decision by an attorney who faces a cost-benefit trade-off. Specifically, bringing a lawsuit is costly to a plaintiff's attorney, and the attorney uses fundamental information to assess the potential compensation that can be obtained with litigation.[10] The attorney's legal cost introduces a friction, because the attorney would not rationally litigate for all undisclosed but only for sufficiently unfavorable information. The magnitude of the legal cost serves as our measure for litigation risk, as a high cost deters litigation and thus reduces litigation risk. It further yields a setting that reconciles well with empirical regularities, most notably the asymmetric market reactions regularity documented by Skinner (1994), Kothari et al. (2009), and Baginski et al. (2018), among others.

We also add to the recent literature on the real effects of the institutional environment. We focus on innovation incentives, following Laux and Stocken (2018).[11] They study the consequences of ex post reporting regulation for firms' innovation incentives, using a variant of Dye (2002) classification model in which a regulator designs and enforces a classification standard and penalizes noncompliance. They find that innovation first increases and then decreases with the stringency of classification standards. We consider the ex ante effects of shareholder litigation in a disclosure setting and show that shareholder litigation can lead to more or less innovation, and that the effect of changes in litigation risk on innovation can be nonmonotonic. These results arise from the trade-off between the deterrence and insurance effects of litigation.

[10] Another difference from the mentioned studies is that we assume that D&O litigation insurance covers all compensation and settlement payments, instead of the insider, the firm, or the auditor. See also Caskey (2013).

[11] Guttman and Meng (2021) also use the Dye (1985) and Jung and Kwon (1988) model and study project selection and project scale decisions by a manager, which are influenced by the prospect of later voluntary disclosure.

3 Model

3.1 Model setup

Fundamental problem and disclosure. The model is based on the standard voluntary disclosure model of Dye (1985) and Jung and Kwon (1988), which features a parsimonious adverse selection problem. An insider, the entrepreneur (she), aims to sell her firm for liquidity reasons to atomistic uninformed investors (they) in a perfectly competitive capital market. The entrepreneur is thus interested in maximizing the short-term stock price. With some probability, she obtains private value-relevant information, which she decides whether to disclose publicly. Following Dye (1985) and Jung and Kwon (1988), disclosure is costless and must be truthful, and all parties are risk neutral.

At $t = 0$,the entrepreneur starts the firm and obtains the exclusive rights to the uncertain fundamental cash flow $\widetilde{x}$, which is continuously distributed over the support $(\underline{x}, \overline{x})$ with $-\infty \leq \underline{x} < \overline{x} \leq \infty$. The p.d.f. of $\widetilde{x}$ is denoted with $f(x)$ and the c.d.f. with $F(x)$, both of which are differentiable over the full support. In addition, we assume that the p.d.f. $f(x)$ is weakly unimodal and symmetric around the finite mean $\mu = E[\widetilde{x}]$.[12]

At $t = 1$, the entrepreneur privately observes a signal about $\widetilde{x}$ with probability $p \in (0, 1)$, where we interpret p as the level of information asymmetry between the entrepreneur and investors. For simplicity, we assume that the signal is perfectly informative about $\widetilde{x}$, so that we need not distinguish between the signal and the fundamental cash flow. We use an indicator variable, $\Omega \in \{0, 1\}$, for the entrepreneur's information endowment, where $\Omega = 1$ indicates an informed and $\Omega = 0$ an uninformed entrepreneur. If the entrepreneur observes $\widetilde{x} = x$, she decides whether to disclose it; otherwise she cannot disclose (as disclosure must be truthful). We indicate the events of disclosure and nondisclosure with D and ND, respectively. The set of disclosed realizations of $\widetilde{x} = x$ is denoted by X_D, and the set of withheld realizations of $\widetilde{x} = x$ is denoted by X_{ND}. If the entrepreneur remains uninformed, she cannot credibly communicate her lack of information to the market.

At $t = 2$, investors competitively price the firm, conditional on all information available to them. If $\widetilde{x} = x$ is disclosed, the market price is $P_D(x)$, which depends on x; otherwise the price is P_{ND}. Because of the intent to sell the firm, the entrepreneur's aim is to maximize the stock price at $t = 3$. Since prices weakly increase in x (we subsequently show that this always holds true), she has an incentive to disclose sufficiently favorable information ($\widetilde{x} = x \geq \tau$) and to withhold sufficiently unfavorable information ($\widetilde{x} = x < \tau$), where τ denotes the threshold for which she is indifferent.[13]

Private litigation. We augment this base model with a strategic litigation mechanism that exhibits the features discussed in the introduction. Withholding unfavorable information harms investors because they pay an inflated price for the firm. A price is

[12] Examples of distributions for which these assumptions hold are uniform and normal distributions. They satisfy the property that the c.d.f. $F(x)$ is weakly convex for $x < \mu = E[\widetilde{x}]$, where this is sufficient to prove uniqueness of the disclosure equilibrium.

[13] We show below that such a disclosure strategy is always an element of the entrepreneur's equilibrium disclosure strategy, consistent with Dye (1985) and Jung and Kwon (1988).

inflated if it is higher than the hypothetical price they would have paid had an informed entrepreneur disclosed her private information. Consequently, the investors' damage upon nondisclosure is

$$\max\{P_{ND} - P_D(\widetilde{x}), 0\}.$$

Securities and disclosure regulation requires full disclosure of all material information and endows investors with the right to file a lawsuit for damage compensation.[14]

To bring a lawsuit, plaintiffs must substantiate their damage claims to be admitted to court. Applicable evidence typically comes from a fundamental signal about the cash flow that arises at $t = 3$. To further simplify the analysis, we assume that a signal always arises and this signal is perfectly informative about $\widetilde{x}$ and simply use $\widetilde{x} = x$ for this signal. That is, the entrepreneur's private information, if observed, and the later public signal are perfectly correlated. If investors observe $\widetilde{x} = x < \tau$ but no disclosure occurred at $t = 1$, the entrepreneur may have been informed but may have withheld unfavorable information. The investors then approach an attorney (he), who decides whether to sue on behalf of investors. Litigation is privately costly to the attorney, with a fixed legal cost $c > 0$ that is public knowledge. This cost includes direct costs of litigation, such as filing fees, as well as the costs of the attorney's effort and opportunity costs of time to prepare and bring the case.[15]

In the event of a lawsuit, the court perfectly discovers whether the entrepreneur became informed and thus knew $\widetilde{x} = x$ at $t = 1$ but chose to withhold this information.[16] If the court uncovers withholding, it orders the firm to pay damages to the investors. Since the attorney bears the cost of a lawsuit, he receives a fraction $(1 - \gamma) \in (0, 1)$ of the damages, and investors retain the remaining fraction γ. As shown later, the attorney rationally sues if $\widetilde{x} = x$ is sufficiently unfavorable; that is, $\widetilde{x} = x \leq \rho < \tau$, where ρ is the attorney's endogenous litigation threshold.[17] We denote the set of realizations $\widetilde{x} = x$ for which the attorney sues in equilibrium with X_L. Moreover, if the litigation succeeds, the entrepreneur incurs a private penalty $k > 0$, which captures, for instance, unfavorable career outcomes.[18]

[14] For example, in the United States, investors are endowed with litigation rights under Rule 10b-5 of the Securities Exchange Act of 1934.

[15] In practice, the legal cost may also depend on a hurdle of minimum evidence that must be submitted to the court and is thus subject to judicial materiality considerations. For example, the PSLRA increased the evidence burden for plaintiffs to sue in the United States, which is commonly believed to have weakened shareholders' litigation rights (Ali and Kallapur 2001; Johnson et al. 2001; Johnson et al. 2007).

[16] Recall that we assume truthtelling, as do Dye (1985) and Jung and Kwon (1988), which implies that the court can verify truthful disclosure of x. Thus no legal claim arises in case of disclosure.

[17] We assume that the attorney's legal cost is independent of the cash flow $\widetilde{x}$. Assume otherwise that $c = c(x)$. If the cost increases in x (i.e., $\frac{\partial c(x)}{\partial x} > 0$), then the attorney's strategy to rationally sue for sufficiently unfavorable information continues to hold. If on the other hand the cost decreases in x (i.e., $\frac{\partial c(x)}{\partial x} < 0$), then the outlined strategy obtains as long as the attorney's expected compensation decreases more in x than his legal cost.

[18] We assume that the penalty is constant and independent of investors' losses. It can be shown that a sufficiently large penalty that is linear in investors' losses would rule out our main case. However, as long as the penalty has a fixed component and the weight on the variable component is not too large or the penalty includes a nonlinear component that is strictly concave (e.g., $\beta\sqrt{P_{ND} - P_D(\widetilde{x})}$), our main results continue to hold.

Anticipating the possibility of litigation, at $t = 0$, the entrepreneur purchases litigation insurance in a competitive insurance market, where the insurance premium $w \geq 0$ is set equal to the expected damage compensation. The premium is paid by the firm and therefore reduces the firm's terminal value, which equals $\widetilde{x} - w$.[19] We assume that the insurance coverage and the premium are publicly observable.[20] In the event of successful litigation, the insurance covers the entire damage compensation.[21] However, it covers neither the entrepreneur's penalty nor the attorney's legal cost. This is consistent with regulatory practice in the United States. Finally, we assume a zero interest rate and thus ignore discounting effects for all players. Figure 1 summarizes the sequence of events.

3.2 Equilibrium

Equilibrium definition. We search for pure strategies Perfect Bayesian Equilibria with threshold strategies for the entrepreneur's disclosure and the attorney's litigation decisions. Each player rationally conjectures the other players' unobservable strategies (denoted with a hat "^") as well as their own future strategies and uses all available information in their decisions. We define an equilibrium as follows.

Definition 1 *An equilibrium consists of a litigation insurance premium at $t = 0$, an informed entrepreneur's disclosure strategy at $t = 1$, the investors' pricing at $t = 2$, and the attorney's litigation strategy at $t = 3$, such that:*

(i) The litigation insurance premium equals the expected damage compensation paid to investors and their attorney.
(ii) Conditional on the entrepreneur observing $\widetilde{x} = x$ at $t = 1$, she discloses if her expected utility from disclosure is larger than from nondisclosure.
(iii) Conditional on observing $\widetilde{x} = x$ in case of disclosure or on the inference drawn from nondisclosure, investors competitively price the firm.
(iv) Conditional on nondisclosure at $t = 1$ and $\widetilde{x} = x$ at $t = 3$, the attorney files a lawsuit if his expected utility from litigation is larger than from no litigation.

In equilibrium, the conjectured strategies equal the actual strategies.

We solve the model by first studying the attorney's litigation decision. Then we consider the entrepreneur's disclosure decision, using conjectures of the market prices before deriving them. Finally we derive the litigation insurance premium. This sequence is chosen for presentation purposes. Formal proofs are in the appendix.

[19] For simplicity, we allow for negative terminal values, which can arise due to the distributional assumptions on $\widetilde{x}$ and due to the insurance premium that is paid by the firm. To avoid such cases, one could assume sufficient assets in place without changing any of our results.

[20] This assumption is without loss of generalizability as the same equilibrium also arises if the premium were unobservable to investors and the attorney. The reason is that the premium does not convey any private information. See Jia and Suijs (2023) for a study on informative insurance coverage disclosure.

[21] Many insurance contracts feature deductibles so that insured parties do not receive full compensation for their losses (Rothschild and Stiglitz 1976). Introducing a fixed amount that is not reimbursed but must be covered by the firm into our model means that investors essentially pay their damages out of their own

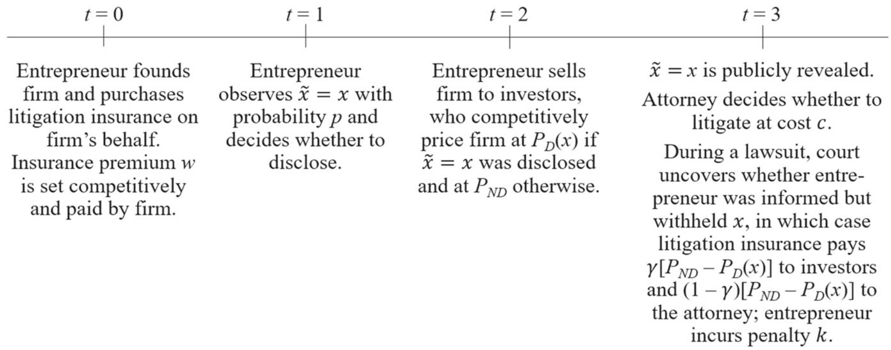

Fig. 1 Timeline

The attorney's litigation decision. If the entrepreneur disclosed $\widetilde{x} = x$ at $t = 1$, investors incorporate this information to determine the market price of the firm, $P_D(x)$ at $t = 2$, and there is no basis for litigation at $t = 3$. If there was no disclosure (ND), then investors observe $\widetilde{x} = x$ at $t = 3$ and consult the attorney on whether to litigate. The attorney assesses potential damages and thus his expected compensation using a rational conjecture of the price $\hat{P}_D(x)$ that investors would have paid had $\widetilde{x} = x$ been disclosed at $t = 1$, where the attorney conjectures that $\hat{P}_D(x)$ is an increasing function of x. The attorney also takes into account that an informed entrepreneur would have disclosed if $\widetilde{x} = x \in X_D$. This implies that, if he observes $\widetilde{x} = x \in X_D$ at $t = 3$, he concludes that the entrepreneur must have been uninformed at $t = 1$. Then it is not rational for him to sue since he cannot succeed in court. In contrast, if the attorney observes $\widetilde{x} = x \in X_{ND}$, he infers that the entrepreneur may have been informed but may have decided to withhold. Then he files a lawsuit if his share of the expected damage compensation outweighs the legal cost; that is,

$$(1 - \gamma) \Pr(\Omega = 1 | \widetilde{x} = x \in X_{ND}, ND) \left[P_{ND} - \hat{P}_D(x) \right] - c \geq 0, \tag{1}$$

where the first term is the attorney's conditionally expected compensation, consisting of the posterior probability that the entrepreneur was informed, conditional on observing $\widetilde{x} = x \in X_{ND}$ at $t = 3$ and nondisclosure at $t = 1$, and the attorney's share of the compensation.

Based on the signal $\widetilde{x} = x$ and the fact that $x \in X_{ND}$, the attorney updates his beliefs regarding his expected compensation in two ways. First, he can accurately estimate the amount of the damage that investors might have suffered and thus the amount of compensation that might be awarded to him. Investors' damages equal the market price P_{ND} less the hypothetical price $\hat{P}_D(x)$. Conjecturing that $\hat{P}_D(x)$ increases in x, the damage decreases in x, which implies that withholding worse news comes with larger damages, such that a lawsuit becomes increasingly desirable to the attorney.

pocket (Caskey 2013). This somewhat weakens the insurance effect of litigation rights. Yet, as long as deductibles are not excessive, their inclusion does not qualitatively affect our results.

Second, by observing $\widetilde{x} = x \in X_{ND}$ after nondisclosure at $t = 1$, the attorney updates his belief about the entrepreneur's likelihood of information endowment and thus of succeeding in court as follows. Recall that the prior probability with which the entrepreneur is informed is p. Upon observing nondisclosure at $t = 1$, the posterior probability of the entrepreneur being informed decreases because an informed entrepreneur who withholds only a subset of realizations of $\widetilde{x} = x$ can pool with an unconstrained set of cash flow realizations for an uninformed entrepreneur. However, when additionally learning that the cash flow is in the nondisclosure set of an informed entrepreneur ($\widetilde{x} = x \in X_{ND}$), this inference of a nondisclosure is undone, and the belief reverts back to the prior belief.[22] Formally,

$$\Pr(\Omega = 1|\widetilde{x} = x \in X_{ND}, ND) = \frac{f(\widetilde{x}|\widetilde{x} = x \in X_{ND})p}{f(\widetilde{x}|\widetilde{x} = x \in X_{ND})[p + (1-p)]} = p.$$

To determine whether litigation is desirable, the attorney compares his expected compensation with the legal cost c. For bounded distributions ($-\infty < \underline{x} < \overline{x} < \infty$), if the cost is so high that it outweighs even the highest expected compensation, litigation never occurs. We henceforth assume that, for such distributions, the legal cost is bounded from above; that is, $c < \bar{c}$.[23] Then the attorney considers litigation for sufficiently low realizations of $\tilde{x} = x$. The threshold $\tilde{x} = x = \rho$ for which the attorney is indifferent arises from the following condition:

$$(1-\gamma)p\left[P_{ND} - \hat{P}_D(\rho)\right] - c = 0. \tag{2}$$

The entrepreneur's disclosure decision. If the entrepreneur does not observe $\tilde{x}$, she cannot disclose. If she observes $\tilde{x} = x$, she decides whether to disclose her information. She conjectures that investors price the firm at $\hat{P}_D(x)$ and at $\hat{P}_{ND}$ upon disclosure and nondisclosure, respectively. She is also aware that investors and their attorney will eventually observe $\widetilde{x} = x$ at $t = 3$, and she conjectures that they will sue if $\widetilde{x} = x \leq \hat{\rho}$. If $\widetilde{x} = x > \hat{\rho}$, the entrepreneur rationally conjectures that litigation will be unprofitable for the attorney and discloses whenever

$$\hat{P}_D(x) \geq \hat{P}_{ND}.$$

Conjecturing that the disclosure price increases in x, the entrepreneur discloses whenever her private information exceeds a threshold; that is, $\widetilde{x} = x \geq \tau$, where τ is defined by

$$\hat{P}_D(\tau) = \hat{P}_{ND}. \tag{3}$$

If $\widetilde{x} = x \leq \hat{\rho}$, the entrepreneur anticipates that the attorney will rationally litigate upon nondisclosure. Knowing that the lawsuit will reveal that she was informed but chose to withhold her information, she anticipates a penalty k upon nondisclosure,

[22] We thank Robert Göx, Ulrich Schäfer, and Georg Schneider for invaluable discussions that contributed to this intuition.

[23] The formal expression for $\overline{c}$ is derived in the appendix.

and she discloses any $\widetilde{x} = x$ for which

$$\hat{P}_D(x) \geq \hat{P}_{ND} - k$$

to avoid the penalty. Condition (3) implies that $\hat{P}_{ND} \geq \hat{P}_D(x)$ must hold for any $\widetilde{x} = x \leq \hat{\rho}$, so that the condition can be rewritten to

$$\hat{P}_{ND} - \hat{P}_D(x) \leq k. \tag{4}$$

Depending on the support of $\widetilde{x}$ (whether it is bounded or unbounded) and on the size of the penalty k, this condition may strictly hold, may hold with equality, or may not bind. This leads to three cases. First, assume that the penalty is such that condition (4) binds for some $x \in (\underline{x}, \hat{\rho}]$. This implies that there must exist a threshold $\widetilde{x} = x = \theta \leq \hat{\rho}$, which is defined by

$$\hat{P}_{ND} - \hat{P}_D(\theta) = k. \tag{5}$$

In this case, the entrepreneur's natural incentive to disclose favorable information and withhold unfavorable information not only arises in the subset of realizations for which litigation is not rational, that is, for $\widetilde{x} = x > \hat{\rho}$, but also for $\widetilde{x} = x \leq \hat{\rho}$ for which litigation is rational. Thus she discloses intermediately unfavorable information in the interval $(\theta, \hat{\rho}]$ and withholds information up to θ. The disclosure of intermediately unfavorable information is a consequence of the *deterrence effect* of private litigation, as the marginal pricing benefit from nondisclosure is below the penalty such that withholding is undesirable.

Second, we compare conditions (5) and (2) as follows:

$$\begin{gathered}\hat{P}_{ND} - \hat{P}_D(\theta) = k \Leftrightarrow \hat{P}_D(\theta) = \hat{P}_{ND} - k, \\ (1-\gamma)p\left[\hat{P}_{ND} - \hat{P}_D(\rho)\right] - c = 0 \Leftrightarrow \hat{P}_D(\rho) = \hat{P}_{ND} - \tfrac{c}{(1-\gamma)p}.\end{gathered}$$

Conjecturing that the disclosure price $\hat{P}_D(x)$ increases with x, we require that $\hat{P}_D(\rho) \leq \hat{P}_D(\theta)$ as only then $\theta \leq \rho$. It follows that (4) cannot bind if

$$k < \underline{k} \equiv \frac{c}{(1-\gamma)p}, \tag{6}$$

as then $\theta > \rho$. Thus, if the penalty is small ($k < \underline{k}$), the deterrence effect of litigation is too weak to alter the entrepreneur's disclosure strategy, and she only discloses sufficiently favorable information ($\widetilde{x} = x \geq \tau$). In contrast, if $k \geq \underline{k}$ the deterrence effect is sufficiently strong so that she also discloses some information for which the attorney would profitably litigate.

Third, given that the distribution of $\widetilde{x}$ is bounded from below (i.e., $\underline{x} > -\infty$), another case can obtain under which condition (4) strictly holds. To see this, assume that $\theta \to \underline{x}$, as defined in condition (5). This condition cannot hold with equality for any $x \in (\underline{x}, \hat{\rho}]$ if

$$k \geq \bar{k} \equiv \hat{P}_{ND} - \hat{P}_D(\underline{x}). \tag{7}$$

Thus, for a subset of distributions with bounded support, a case with large penalties ($k \geq \bar{k}$) obtains in which the deterrence effect associated with litigation is so strong that the entrepreneur discloses all information for which the attorney would profitably sue.

The distinction of these three cases further reveals that the threat of litigation may not only impact the entrepreneur's disclosure choices but may also profoundly affect the attorney's behavior. In particular, for small penalties ($k < \underline{k}$), the attorney anticipates that litigation does not directly impact disclosure and sues for all realizations of $\widetilde{x} = x$ for which litigation appears profitable. In contrast, if the penalty is not small ($k \geq \underline{k}$), he anticipates that the entrepreneur discloses any $\tilde{x} = x \in (\theta, \hat{\rho}]$ to deter litigation, and the attorney does not sue for such realizations, as a lawsuit would fail with certainty. In contrast, if the attorney observes $\tilde{x} = x \leq \theta$, he anticipates that an informed entrepreneur would have withheld such information, and, since $\theta \leq \hat{\rho}$, he sues on behalf of investors. The entrepreneur anticipates litigation, but the short-term improvement in the stock price exceeds the penalty, such that she withholds very unfavorable information. In the special case with bounded distributions and a sufficiently large penalty ($k \geq \bar{k}$), this rationale implies a general absence of litigation in equilibrium. Overall the deterrence effect of litigation is an out-of-equilibrium threat that can be strong enough to discipline not only the entrepreneur's disclosures but also the attorney's motivation to sue.

Capital market pricing. If the entrepreneur became informed and chose to disclose $\widetilde{x} = x$ at $t = 2$, investors price the firm at its conditionally expected terminal value, such that

$$P_D(x) = x - w, \tag{8}$$

which uses the fact that the entrepreneur's information is perfect and the insurance premium paid by the firm is unobservable to investors. Note that the disclosure price linearly increases with x with a slope coefficient of 1, consistent with the conjecture from the attorney's and the entrepreneur's decision problems.

Upon nondisclosure, investors rationally conjecture that either the entrepreneur was uninformed (probability $1-p$) or was informed but chose to withhold her private information (probability p). The conditionally expected terminal value upon nondisclosure is therefore

$$E[(\tilde{x} - w)|ND] = \Pr(\Omega = 1, \tilde{x} \in X_{ND}|ND)E[\tilde{x}|\tilde{x} \in X_{ND}] + \Pr(\Omega = 0|ND)E[\tilde{x}] - w.$$

Since investors condition on the nondisclosure, their expectation of the terminal value depends on their conjectures about the entrepreneur's disclosure behavior, and we have already established that the latter depends on the distribution on $\widetilde{x}$ and penalty k. This implies the following expectations:

$$E[(\tilde{x}-w)|ND]=\begin{cases} \dfrac{pF(\hat{\tau})E[\tilde{x}|\tilde{x}<\hat{\tau}]+(1-p)\mu}{pF(\hat{\tau})+(1-p)} - w & \text{if } k < \underline{k} \\ \dfrac{p\left\{F(\hat{\theta})E\left[\tilde{x}|\tilde{x}<\hat{\theta}\right]+[F(\hat{\tau})-F(\hat{\rho})]E[\tilde{x}|\hat{\rho}<\tilde{x}<\hat{\tau}]\right\}+(1-p)\mu}{p\left\{F(\hat{\theta})+[F(\hat{\tau})-F(\hat{\rho})]\right\}+(1-p)} - w & \text{if } \underline{k} \leq k < \min\{\bar{k}, \infty\} \\ \dfrac{p[F(\hat{\tau})-F(\hat{\rho})]E[\tilde{x}|\hat{\rho}<\tilde{x}<\hat{\tau}]+(1-p)\mu}{p[F(\hat{\tau})-F(\hat{\rho})]+(1-p)} - w & \text{if } k \geq \min\{\bar{k}, \infty\} \end{cases}.$$

Given that litigation is an equilibrium event (i.e., $k < \min\{\bar{k}, \infty\}$), upon nondisclosure, investors price the firm at its conditionally expected terminal value. They also rationally anticipate that they will observe $\tilde{x} = x$ at $t = 3$ and that the attorney will rationally sue on their behalf for realizations $\tilde{x} = x \leq \hat{\rho}$ and $\tilde{x} = x \leq \hat{\theta}$ for $k < \underline{k}$ and $\underline{k} \leq k < \min\{\bar{k}, \infty\}$, respectively. Since the possibility of litigation affects their future payoffs, they price the expected compensation from litigation as part of the price they are willing to pay for the firm upon nondisclosure. Therefore litigation rights induce an *insurance effect*, in that they protect investors against the losses incurred from strategic withholding by an informed entrepreneur. Investors relax their price protection and, in part, increase the losses that they might incur. Formally, the conditionally expected value of litigation is

$$\gamma \Pr(\Omega = 1, \tilde{x} \in X_L | ND) E[P_{ND} - \hat{P}_D(\tilde{x}) | X_L]$$
$$= \begin{cases} \gamma \frac{pF(\hat{\rho})[P_{ND} - (E[\tilde{x}|\tilde{x} \leq \hat{\rho}] - \hat{w})]}{pF(\hat{\tau}) + (1-p)} & \text{if } k < \underline{k} \\ \gamma \frac{pF(\hat{\theta})\left[P_{ND} - \left(E\left[\tilde{x}|\tilde{x} \leq \hat{\theta}\right] - \hat{w}\right)\right]}{p\left\{F(\hat{\theta}) + [F(\hat{\tau}) - F(\hat{\rho})]\right\} + (1-p)} & \text{if } \underline{k} \leq k < \min\{\bar{k}, \infty\} \end{cases}. \tag{9}$$

Taken together, the nondisclosure price P_{ND} that investors are willing to pay for the firm at $t = 3$ is implicitly defined by

$$P_{ND} + \hat{w}$$
$$= \begin{cases} \frac{pF(\hat{\tau})E[\tilde{x}|\tilde{x} < \hat{\tau}] + (1-p)\mu + \gamma pF(\hat{\rho})[P_{ND} - (E[\tilde{x}|\tilde{x} \leq \hat{\rho}] - \hat{w})]}{pF(\hat{\tau}) + (1-p)} & \text{if } k < \underline{k} \\ \frac{pF(\hat{\theta})\left\{E\left[\tilde{x}|\tilde{x} < \hat{\theta}\right] + \gamma\left[P_{ND} - \left(E\left[\tilde{x}|\tilde{x} \leq \hat{\theta}\right] - \hat{w}\right)\right]\right\} + p[F(\hat{\tau}) - F(\hat{\rho})]E[\tilde{x}|\hat{\rho} < \tilde{x} < \hat{\tau}] + (1-p)\mu}{p\left\{F(\hat{\theta}) + [F(\hat{\tau}) - F(\hat{\rho})]\right\} + (1-p)} & \text{if } \underline{k} \leq k < \min\{\bar{k}, \infty\} \\ \frac{p[F(\hat{\tau}) - F(\hat{\rho})]E[\tilde{x}|\hat{\rho} < \tilde{x} < \hat{\tau}] + (1-p)\mu}{p[F(\hat{\tau}) - F(\hat{\rho})] + (1-p)} & \text{if } k \geq \min\{\bar{k}, \infty\} \end{cases}. \tag{10}$$

Note that, when setting the disclosure price according to Eq. (8) and the nondisclosure price according to Eq. (10), investors consider the premium for D&O litigation insurance paid by the firm, w, at $t = 0$. Since the disclosure and litigation strategies are functions of the difference between the prices (i.e., $P_{ND} - P_D(x)$), the premium affects neither the entrepreneur's nor the attorney's decisions. This is intuitive, as the premium is a sunk cost.

Litigation insurance premium. In a last step, we solve for the litigation insurance premium set by a perfectly competitive insurance market at $t = 0$. The insurer conjectures that litigation would only occur in equilibrium if the entrepreneur were informed and decided to withhold at $t = 1$ and the attorney rationally pursues litigation at $t = 3$. It further conjectures the pricing decisions of investors upon disclosure and nondisclosure ($\hat{P}_D(\widetilde{x})$ and $\hat{P}_{ND}$, respectively) and forms an expectation about the damage compensation that it pays out to investors and the attorney in case of successful litigation. Intuitively, the insurer will only demand a nonzero insurance premium ($w > 0$) if litigation is an equilibrium event (i.e., $k < \min\{\bar{k}, \infty\}$). In these cases, the insurance premium is

$$w = \Pr(\Omega = 1, X_L) E[\hat{P}_{ND} - \hat{P}_D(\tilde{x}) | X_L]$$

$$= \begin{cases} pF(\hat{\rho}) \left[\hat{P}_{ND} - \left(E\left[\tilde{x} | \tilde{x} \leq \hat{\rho} \right] - w \right) \right] & \text{if } k < \underline{k} \\ pF(\hat{\theta}) \left[\hat{P}_{ND} - \left(E\left[\tilde{x} | \tilde{x} \leq \hat{\theta} \right] - w \right) \right] & \text{if } \underline{k} \leq k < \min\{\bar{k}, \infty\} \end{cases} . \quad (11)$$

Since the insurance premium is determined at $t = 0$, it is constant for the subsequent game and does not affect the disclosure equilibrium.

Equilibrium. In equilibrium, all conjectures must equal their actual strategies; that is, $\hat{\tau} = \tau$, $\hat{\rho} = \rho$, $\hat{\theta} = \theta$, $\hat{P}_D(x) = P_D(x)$ and $\hat{P}_{ND} = P_{ND}$. The following theorem states the entrepreneur's and the attorney's equilibrium strategies and establishes the existence of the unique threshold equilibrium.

Theorem 1 *There exists a unique threshold equilibrium with the following disclosure and litigation strategies.*

(i) *For small penalties ($k < \underline{k}$), the entrepreneur discloses favorable information ($\tilde{x} = x \geq \tau$), and the attorney litigates for very unfavorable information ($\tilde{x} = x \leq \rho$), where thresholds $\tau > \rho$ are defined by conditions (3) and (2), respectively.*

(ii) *For intermediate penalties ($\underline{k} \leq k < \min\{\bar{k}, \infty\}$), the entrepreneur discloses favorable information ($\tilde{x} = x \geq \tau$) and very unfavorable information ($\tilde{x} = x \in (\theta, \rho]$), and the attorney litigates for extremely unfavorable information ($\tilde{x} = x \leq \theta$), where thresholds $\tau > \rho \geq \theta$ are defined by conditions (3), (2), and (5), respectively.*

(iii) *For large penalties ($k \geq \min\{\bar{k}, \infty\}$), the entrepreneur discloses favorable information ($\tilde{x} = x \geq \tau$) and very unfavorable information ($\tilde{x} = x < \rho$), and the attorney never litigates, where thresholds $\tau > \rho$ are defined by conditions (3) and (2), respectively.*

Discussion. Our analysis establishes the existence of a unique threshold equilibrium for any penalty $k > 0$. Yet the characteristics of the equilibrium differ for different penalty levels. Figure 2 illustrates the equilibrium disclosure and litigation strategies for the three possible cases.

For intermediate penalties (Theorem 1 (ii)), there are two disjoint disclosure sets, two disjoint nondisclosure sets, and one set of signals for which the attorney rationally litigates. The informed entrepreneur discloses sufficiently favorable information ($x \geq \tau$), as this strategy yields a higher price than the equilibrium nondisclosure price. Additionally, she discloses very unfavorable information ($x \in (\theta, \rho]$) for which she would otherwise expect the attorney to file a lawsuit, carrying a penalty k that outweighs the marginal pricing benefit of nondisclosure. Disclosure then prevents litigation. For intermediate information ($x \in (\rho, \tau)$), litigation is too costly, compared to the compensation the attorney expects to receive. In addition, the disclosure price falls short of the nondisclosure price, so that the entrepreneur withholds the information. Lastly, for extremely unfavorable information ($x \leq \theta$), the entrepreneur withholds, establishing a legal claim, and the attorney litigates in equilibrium.

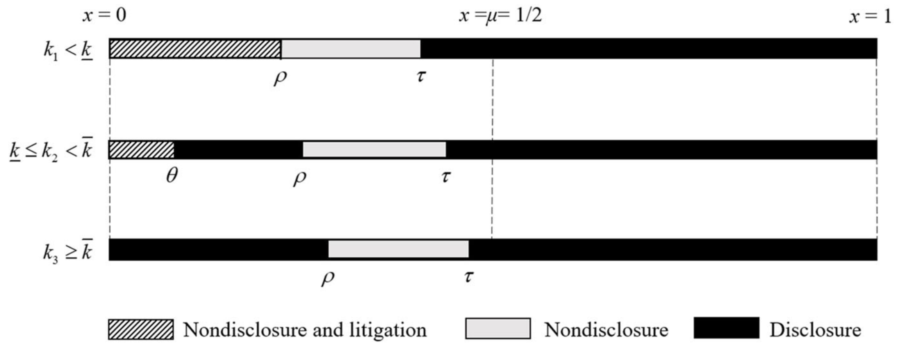

Fig. 2 Equilibrium strategies. This figure illustrates the disclosure, nondisclosure, and litigation regions for all feasible signals $\tilde{x} = x$ in each of the three cases that differ by the penalty k. $k_1 = 0.1$ represents small, $k_2 = 0.35$ intermediate, and $k_3 = 0.6$ large penalties. The other parameters underlying this figure are $p = 0.7$, $\gamma = 0.6$, $c = 0.05$, and $\tilde{x} \sim U(0, 1)$

The equilibrium structures with small and large penalties feature simpler strategies than in the intermediate penalty case. If penalties are small (Theorem 1 (i)), there is only one disclosure ($x \geq \tau$) and one nondisclosure interval ($x < \tau$). Similar to the case with intermediate penalties, upon nondisclosure the attorney only sues when the later information $\tilde{x} = x$ is sufficiently unfavorable ($x \leq \rho$). If penalties are large (Theorem 1 (iii)), the equilibrium features two disclosure intervals ($x \geq \tau$, $x \leq \rho$) and one nondisclosure interval ($x \in (\rho, \tau)$). Here the penalties are large enough to deter the entrepreneur from withholding any $\tilde{x} = x$ for which she anticipates the attorney to rationally litigate; that is, $\tilde{x} = x \leq \rho$. This disclosure strategy preempts litigation in equilibrium, so that litigation is solely an out-of-equilibrium threat.

We next reconcile our model with the literature. First, if the legal cost is excessive ($c \to \min\{\bar{c}, \infty\}$), then investors and the attorney never litigate, and the disclosure threshold resembles the one established by Dye (1985) and Jung and Kwon (1988); that is,[24]

$$\tau = \frac{pF(\tau)E\left[\tilde{x}|\tilde{x} < \tau\right] + (1-p)\mu}{pF(\tau) + (1-p)}.$$

If litigation is costless ($c = 0$) and the entrepreneur's penalty is small enough ($k < \underline{k}$), then the equilibrium is structurally similar to the one of Dye (2017), in which investors are always compensated whenever an informed entrepreneur can rationally be expected to have withheld information. In our setting, this would be reflected by $\rho = \tau$. However, litigation does not directly affect the entrepreneur's disclosure decision, as the penalty is too small. Then the disclosure threshold is implicitly characterized by

$$\tau = \frac{pF(\tau)\left\{\gamma\tau + (1-\gamma)E\left[\tilde{x}|\tilde{x} < \tau\right]\right\} + (1-p)\mu}{pF(\tau) + (1-p)} - w,$$

[24] In this case, the equilibrium insurance premium is $w = 0$.

where the nondisclosure price includes the expected utility from future litigation, reflecting the insurance effect of litigation rights. This insurance effect is consistent with the results of Arrow (1965), as litigation rights alleviate investor price protection and thus lead to larger damages.

We focus on cases in which the legal cost is $c \in (0, \min\{\bar{c}, \infty\})$, so that the plaintiff's attorney nontrivially trades off expected benefits and costs of litigation. The attorney would only sue for very unfavorable information ($x \leq \rho$) but not for intermediately unfavorable information, even though he knows that there is a chance that an informed entrepreneur may have withheld information $x \in (\rho, \tau)$. However, then the expected compensation does not outweigh the legal cost.

Turning to the relevance of penalties, Skinner (1994, 1997) argues that shareholder litigation imposes significant penalties on insiders, inducing them to disclose information to avert litigation. This argument is consistent with the deterrence effect first described by Becker (1968). If the entrepreneur's penalty is large enough ($k > \underline{k}$), this effect arises in our setting, and we show that litigation affects disclosure as an out-of-equilibrium threat. For bounded distributions and very large penalties ($k \geq \bar{k}$), our setting reconciles with that of Trueman (1997), in which the entrepreneur discloses both sufficiently favorable ($x \geq \tau$) and very unfavorable information ($x \leq \rho$) and withholds intermediate information for which litigation is not profitable for the attorney. Then no litigation occurs in equilibrium, and no damage compensation is impounded into the nondisclosure price.

For the remainder of the paper, we assume that the cash flow $\tilde{x}$ is uniformly distributed over the unit interval, that is, $\tilde{x} \sim U(0, 1)$, to facilitate the formal analysis. In addition, we focus on the case with intermediate penalties $\underline{k} \leq k < \bar{k}$ for two reasons. The first is that it is the only case in which both the deterrence and insurance effects of litigation arise simultaneously and codetermine the equilibrium disclosure strategies. This rules out the case with small penalties ($k < \underline{k}$), as, in this case, the deterrence effect is mute and does not codetermine equilibrium behavior, where this contrasts with the widespread consensus in the literature (e.g., Skinner 1994, 1997). The second reason is that the case with large penalties does not feature litigation as an equilibrium event and consequently no market for litigation insurance, counter to business practice.

4 Private litigation and corporate disclosure

4.1 Litigation risk and disclosure likelihood

In this section, we establish key properties that are exhibited by the unique equilibrium for intermediate penalties. To facilitate the discussion, we define a number of aggregate measures. The overall amount of disclosed information can be captured by the likelihood of disclosure, which is

$$DL \equiv p(1 - \tau) + p(\rho - \theta).$$

The likelihood of litigation is defined as

$$ALR \equiv \theta.$$

This measure only captures the likelihood with which litigation occurs in equilibrium and thus actual litigation risk. Yet, as discussed earlier, litigation also impacts disclosure by establishing an out-of-equilibrium threat. To capture the litigation risk as perceived by the entrepreneur, we use the likelihood with which the attorney rationally litigates in- and off-equilibrium,

$$PLR \equiv \rho.$$

The next corollary states the effect of a variation of the attorney's legal cost c on actual and perceived litigation risk.

Corollary 1 *Increasing the attorney's legal cost c decreases actual and perceived litigation risk* ($\frac{dALR}{dc} < 0$, $\frac{dPLR}{dc} < 0$).

The legal cost disciplines the attorney's litigation decision, inducing the attorney to consider litigation for fewer intermediately unfavorable signals (ρ decreases). This decreases the perceived litigation risk. An increase of the legal cost also decreases actual litigation risk, but the effect is more subtle. To explain this, assume that increasing the legal cost leads to a decline of the nondisclosure price P_{ND}. Then the entrepreneur discloses more very unfavorable information (θ decreases), as the marginal benefit of withholding information for which the attorney would litigate declines. The additional disclosure of very unfavorable information deters litigation in equilibrium, and actual litigation risk declines. Upon nondisclosure, investors anticipate the decline in the likelihood of litigation by reassessing the expected future compensation from litigation, and they reduce the nondisclosure price.[25]

The main takeaway from Corollary 1 is that the attorney's legal cost primarily determines litigation risk. In our subsequent analyses, we use the legal cost c as a descriptive exogenous variable to provide insights on the effects of changes in litigation risk.

We next state our first main result on the impact of changes in litigation risk on overall disclosure.

Corollary 2 *There exists a unique threshold* $k_{DL} \in [\underline{k}, \bar{k}]$*, such that decreasing litigation risk (increasing c) has the following effects on the disclosure likelihood:*

(i) *If the entrepreneur's penalty is sufficiently small* ($k < k_{DL}$)*, the disclosure likelihood increases* ($\frac{dDL}{dc} > 0$).
(ii) *If the entrepreneur's penalty is sufficiently large* ($k > k_{DL}$)*, the disclosure likelihood decreases* ($\frac{dDL}{dc} < 0$).

[25] Closely related, it is further straightforward to show that, in equilibrium, the premium w decreases as the legal cost c increases and thus as actual litigation risk decreases. This result corresponds to empirical findings that D&O litigation insurance premiums capture firms' level of litigation risk (Core 1997, 2000; Lin et al. 2013; Cao and Narayanamoorthy 2014; Donelson et al. 2018).

Corollary 2 shows that decreasing litigation risk can lead to more or less disclosure, depending on the size of the entrepreneur's penalty k. This result follows from the trade-off between the deterrence and insurance effects of litigation rights. The deterrence effect is such that decreasing litigation risk weakens the entrepreneur's incentives to disclose very unfavorable information, as she anticipates that the attorney is rationally less likely to sue (ρ decreases). Since there is no threat of litigation and thus of incurring a penalty, , the entrepreneur withholds more intermediately unfavorable information.

The insurance effect pulls in the opposite direction. Decreasing litigation risk reduces the expected compensation investors expect to receive, and they price protect more. This leads to a reduction of the nondisclosure price and strengthens the entrepreneur's incentives to disclose more weakly unfavorable information (τ decreases). In total, while the deterrence effect affects the disclosure of intermediately to very unfavorable information, the insurance effect affects the disclosure of weakly unfavorable information.

Which of these effects dominates can also depend on the size of the entrepreneur's penalty. If the penalty is small ($k < \underline{k}$), then the deterrence effect is muted, so that disclosure increases with weakened litigation risk. In contrast, if the penalty is large ($k \geq \bar{k}$), the deterrence effect is so strong that litigation does not occur in equilibrium. Then the insurance effect is muted, and decreasing litigation risk leads to less disclosure of intermediately unfavorable information. For the more interesting intermediate penalty case ($\underline{k} \leq k < \bar{k}$), both effects are active, and either can dominate the equilibrium disclosure.

The result in Corollary 2 depends on the critical level of the penalty k_{DL}. In the next lemma, we provide insights into the determinants of k_{DL} by stating more refined conditions about when either of the two effects dominates in our main case.

Lemma 1 *There exist unique thresholds* $0 < p_{DL} < 1$ *and* $0 < c_{DL}^L < c_{DL}^H < \bar{c}$ *such that:*

(i) *If both information asymmetry is sufficiently large* ($p > p_{DL}$) *and litigation risk is intermediate* ($c_{DL}^L < c < c_{DL}^H$), $k_{DL} \in (\underline{k}, \bar{k})$.

(ii) *If both information asymmetry is sufficiently large* ($p > p_{DL}$) *and litigation risk is low* ($c \geq c_{DL}^H$), $k_{DL} = \bar{k}$.

(iii) *If either information asymmetry is sufficiently small* ($p \leq p_{DL}$) *or litigation risk is high* ($c \leq c_{DL}^L$), $k_{DL} = \underline{k}$.

Lemma 1 highlights that not only the entrepreneur's penalty but also the level of information asymmetry p and litigation risk (measured by the legal cost c) determine whether the deterrence effect or the insurance effect dominates in the intermediate penalty case. If the entrepreneur is more likely informed, the attorney is more likely to sue, as a lawsuit is more likely to succeed. This implies more expected damages for investors. If, in addition, the legal cost is large, such that litigation risk is small, then the threat of litigation does not deter the withholding of very unfavorable information, and the deterrence effect is sufficiently muted. Under these conditions, the insurance effect dominates (Lemma 1 (ii)). Conversely, if either the likelihood of informedness is small or litigation risk is high, the deterrence effect is relatively strong and dominates. Only when the information asymmetry is large and litigation risk is intermediate does

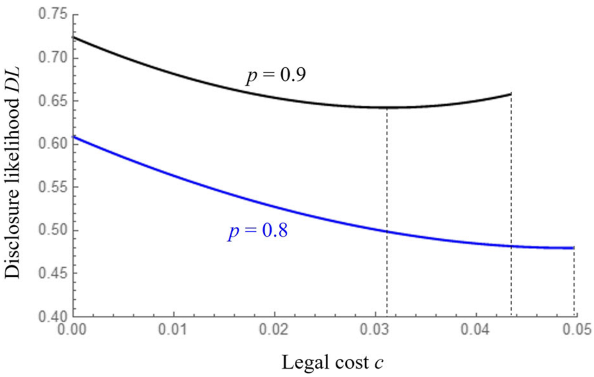

Fig. 3 **Disclosure likelihood and litigation risk**. The underlying parameters are the likelihood of an informed entrepreneur $p = 0.8$ and $p = 0.9$, investors' share of the compensation $\gamma = 0.8$, and penalty $k = 0.2$. DL strictly decreases for all feasible c for $p = 0.8$, whereas DL achieves an interior minimum at $c = 0.031$ for $p = 0.9$

there exist a critical level of penalty for which the two economic effects balance each other in the intermediate penalty case, leading to a threshold k_{DL} different from the boundary values.

Figure 3 illustrates the behavior of the disclosure likelihood DL in equilibrium for a variation of the attorney's legal cost c. The figure presents the result from Lemma 1 in a different way. It shows that, if the likelihood of the entrepreneur being informed is sufficiently small ($p \leq p_{DL}$), then a decrease in litigation risk unambiguously reduces the disclosure likelihood. If it is sufficiently large ($p > p_{DL}$), then a nonmonotonic association results in that the disclosure likelihood first decreases (due to the weakening of the deterrence effect) and then increases (due to the weakening of the insurance effect) in the legal cost c.

4.2 Asymmetric market reactions to good and bad news

The equilibrium in Theorem 1 (ii) features disclosure of sufficiently favorable information ($x \geq \tau$) and of some very unfavorable information ($x \in (\theta, \rho]$). Yet this finding does not simply translate into good news and bad news disclosures. Intuitively, good news should be associated with positive *market reactions* and bad news with negative ones. In the appendix, we derive the ex ante price $E[P]$ that a competitive market would set at $t = 0$ before the disclosure decision is made. We use this price to classify disclosures into good and bad news. When the disclosure of $\widetilde{x} = x$ leads to a disclosure price $P_D(x)$ above (below) the ex ante price $E[P]$, then we classify this as good (bad) news.

In equilibrium, we can show that the entrepreneur always discloses information that leads to a positive market reaction and thus all good news. This obtains, as the threshold τ, which arises from her basic incentive to disclose sufficiently favorable information, is strictly below the expected stock price; that is, $\tau - w < E[P]$. This also implies that the entrepreneur always discloses some weakly bad news ($x \in [\tau, E[P]+w)$). In addition, the entrepreneur discloses some very bad news ($x \in (\theta, \rho]$). The magnitudes of the absolute average market reactions to good and bad news are then as follows.

$$MR_G \equiv E[|P_D(\tilde{x}) - E[P]|\,|\tilde{x} \in X_D \cup P_D(\tilde{x}) \geq E[P]],$$
$$MR_B \equiv E[|P_D(\tilde{x}) - E[P]|\,|\tilde{x} \in X_D \cup P_D(\tilde{x}) < E[P]|].$$

The next proposition compares the average market reactions to good and bad news disclosures.

Proposition 1 *There exist unique thresholds $k_{MR} \in [\underline{k}, \bar{k})$ and $c_{MR} \in (0, \bar{c})$, such that the average market reaction to bad news disclosures is larger than to good news ones ($\Delta MR = MR_B - MR_G > 0$) if both litigation risk and the entrepreneur's penalty are sufficiently high ($c < c_{MR}$ and $k > k_{MR}$).*

Proposition 1 suggests that the market on average reacts more to bad news than to good news if the entrepreneur's penalty is large enough ($k > k_{MR}$) and litigation risk is high enough ($c < c_{MR}$). The intuition for these conditions is as follows. The average market reaction to good news is formed over all possible realizations of good news, since all such news is disclosed. For the average market reaction to bad news to be larger, the entrepreneur must have incentives to disclose enough very bad news but to withhold intermediately bad news. The combination of a sufficiently large penalty and sufficiently high litigation risk accomplishes this by inducing sufficiently strong deterrence. An increasingly large penalty induces disclosure of very bad news up to a point where all very bad news is disclosed ($\theta \to 0$). If, in addition, litigation risk is high enough (i.e., ρ is high), the entrepreneur discloses a critical amount of very bad news. However, since litigation is imperfect because it is costly to the attorney, there are always some realizations of $\tilde{x} = x$ for which the attorney refrains from litigation. These realizations are then withheld by the entrepreneur ($x \in (\rho, \tau)$).

Figure 4 plots the difference in market reactions to bad versus good news (ΔMR) with respect to the entrepreneur's penalty and shows that, for sufficiently high litigation risk ($c < c_{MR}$) and a sufficiently large penalty ($k > k_{MR}$), the market reacts on average more to bad news than to good.

5 Private litigation and corporate innovation

Our model features a pure exchange setting with a focus on the endogenous relationship between corporate disclosure and shareholder litigation. However, litigation can also have real effects. In particular, there are concerns that shareholder litigation can discourage corporate innovation. Since innovation helps drive micro- and macroeconomic growth, fostering it matters greatly to regulators (Arrow 1962; Stokey 1995).

We extend our setting to gain insights into how litigation risk affects the entrepreneur's incentives to innovate. Like Laux and Stocken (2018), we model innovation parsimoniously and assume that, at an intermediate date $t = 0.5$, after setting up the firm and purchasing litigation insurance at $t = 0$, the entrepreneur chooses

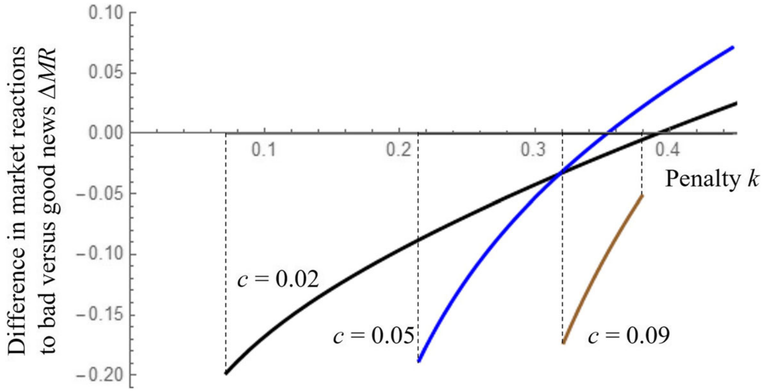

Fig. 4 **Difference in market reactions to bad versus good news**. The figure shows the difference in the market reactions to bad and good news ($\Delta MR = MR_B - MR_G$) as a function of the the penalty k for three different values of legal cost c. The underlying parameters are $p = 0.7$ and $\gamma = 0.6$. Note that $\bar{c} = 0.099$, implying that $c = 0.02$ and $c = 0.05$ represent high-litigation-risk scenarios, as they are below the threshold $c_{MR} = 0.083$, whereas $c = 0.09$ represents a low-litigation-risk scenario

innovative effort $a \in (0, 1)$ at a private cost $a^2/2$. The effort a reflects the probability with which a new product or technology emerges that generates the future cash flow x. The effort is unsuccessful with probability $(1 - a)$. Whether innovative effort succeeds becomes public knowledge at $t = 1$. For instance, the firm can produce a new product or offer a new service that would be infeasible without R&D. Since the effort is chosen and its result becomes observable before the disclosure-pricing-litigation subgame commences, the equilibrium strategies as stated earlier continue to hold. The only effect of introducing innovative effort is on the insurance premium w, because the probability that a viable project arises that eventually gives rise to litigation is anticipated in the premium. Since w is a sunk cost, this does not affect disclosure and litigation decisions. If innovation fails, we assume that the entrepreneur also sells the firm, whose value then comprises the value derived from assets in place (normalized to 0) minus the litigation insurance premium w.

The entrepreneur chooses innovative effort a by maximizing her expected utility,

$$\max_a aEU + (1 - a)(-w) - \frac{a^2}{2},$$

where EU captures her utility from the subsequent disclosure-pricing-litigation subgame if her innovative efforts succeed.

Since EU is independent of a, the optimal innovative effort equals $a = EU + w$. For intermediate penalties ($\underline{k} \leq k < \bar{k}$), the optimal effort is

$$\begin{aligned} a = p\,\{[F(\rho) - F(\theta)]\, E[P_D(\tilde{x})|\theta < \tilde{x} \leq \rho] + [1 - F(\tau)]\, E[P_D(\tilde{x})|\tilde{x} \geq \tau]\} + \\ \{pF(\theta) + p\,[F(\tau) - F(\rho)] + (1 - p)\}\, P_{ND} - pF(\theta)k + w. \end{aligned} \tag{12}$$

The marginal expected utility comprises the net expected price the entrepreneur obtains from selling the firm and the expected penalty she incurs if she becomes informed but withholds and the attorney decides to sue. The expression in Eq. (12) further simplifies to

$$a = \frac{1}{2} + p\theta \left[\gamma \left(\tau - \frac{\theta}{2} \right) - k \right]. \tag{13}$$

As long as there is a unique equilibrium in the disclosure-pricing-litigation subgame, there also exists a unique innovative effort.

One property of the innovative effort is that, if the attorney's legal cost is so large that he never sues ($c \geq \bar{c}$), then $a \to 1/2$. This will serve as a benchmark in the next proposition.

Proposition 2 *There exist unique thresholds* $k_a \in [\underline{k}, \bar{k})$ *and* $c_a \in (0, \bar{c})$ *such that:*

(i) *If both litigation risk is sufficiently high* ($c < c_a$) *and the entrepreneur's penalty is sufficiently small* ($k < k_a$)*, private litigation leads to more corporate innovation* ($a(c < \bar{c}) > a(c \geq \bar{c})$).
(ii) *If either litigation risk is sufficiently low* ($c < c_a$) *or the entrepreneur's penalty is sufficiently large* ($k > k_a$)*, private litigation leads to less corporate innovation* ($a(c < \bar{c}) < a(c \geq \bar{c})$).

Comparing innovative effort with that in a benchmark scenario without private litigation ($c \geq \bar{c}$), Proposition 2 establishes that the threat of litigation can induce more or less innovation. Specifically, innovative effort is larger than the benchmark effort if both litigation risk is high and the entrepreneur's penalty is small, whereas innovative effort is smaller if either of these conditions does not hold. The economic effects underlying this result are again the deterrence and insurance effects of litigation rights.

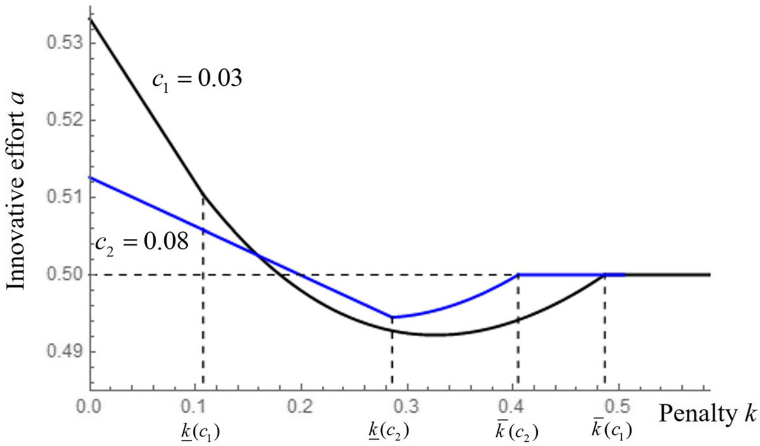

Fig. 5 Corporate innovation and the entrepreneur's penalty. This figure shows the behavior of innovative effort a upon varying the entrepreneur's penalty k for two levels of the legal cost, $c_1 = 0.02$ and $c_2 = 0.08$ (where the latter implies low litigation risk). The parameters underlying the figure are $p = 0.7$ and $\gamma = 0.6$. The interval $k \leq \underline{k}(c)$ reflects small, $\underline{k}(c) < k < \bar{k}(c)$ intermediate, and $k \geq \bar{k}(c)$ large penalty cases for $c = \{c_1, c_2\}$

The deterrence effect discourages innovation because the entrepreneur anticipates the expected penalty incurred if the following sequence of events arises: innovative effort succeeds, the entrepreneur becomes informed but withholds, the attorney sues, and the court learns she was informed. The insurance effect is such that the expected price after successful innovation increases. Since the entrepreneur's payoff to successful innovation increases, the insurance effect therefore amplifies innovation incentives. Which of the two effects dominates depends on both the base level of litigation risk and the size of the entrepreneur's penalty. If litigation risk is large enough ($c > c_a$), litigation induces sufficiently strong economic effects. In addition, as long as the entrepreneur's penalty is small enough ($k < k_a$), the insurance effect dominates, leading to litigation encouraging innovation.

Figure 5 illustrates how the incentives of the entrepreneur to exert innovative effort a vary with respect to penalty k over the full range of k, including the other two cases with small and large penalties. We distinguish between high- and low-litigation-risk scenarios. Our benchmark is the effort $a = 1/2$, which arises if there is no litigation. In general, for sufficiently small penalties, the effort is greater than that without litigation, and the critical value k_a lies either in the small or intermediate penalty case, depending on the baseline level of litigation risk as measured by the legal cost c.

The following corollary states the effects of changing litigation risk on corporate innovation.

Corollary 3 *There exist unique thresholds $k_{\Delta a} \in [\underline{k}, \bar{k})$ and $c_{\Delta a} \in (0, \bar{c})$, such that a change in litigation risk (varying c) has the following effects on corporate innovation.*

(i) *If both the entrepreneur's penalty is sufficiently small ($\underline{k} \leq k \leq k_{\Delta a}$) and litigation risk is sufficiently high ($c < c_{\Delta a}$), corporate innovation increases with litigation risk ($\frac{da}{dc} < 0$).*

(ii) *If either the entrepreneur's penalty is sufficiently large ($k_{\Delta a} < k < \bar{k}$) or litigation risk is sufficiently low ($c_{\Delta a} < c < \bar{c}$), corporate innovation decreases with litigation risk ($\frac{da}{dc} > 0$).*

Corollary 3 establishes that a change in litigation risk can improve or impair entrepreneurial innovation incentives, resulting from the entrepreneur's implicit trade-off between a higher expected price (insurance effect) and a higher expected penalty (deterrence effect). Depending on the penalty, Corollary 3 suggests that innovation can behave nonmonotonically (specifically U-shaped) in litigation risk. The intuition for these conditions is straightforward. If the penalty is small enough ($\underline{k} \leq k \leq k_{\Delta a}$), then the deterrence effect is generally weak. If, in addition, litigation risk is high ($c < c_{\Delta a}$), this implies a strong insurance effect, such that decreasing litigation risk weakens this effect. The result is a positive association between litigation risk and innovation. If neither of these conditions holds, then changing litigation risk has a disproportionately stronger impact on the deterrence effect, such that a negative association arises. This implies that, given sufficiently small penalties, innovation first decreases (due to the deterrence effect) and then increases with litigation risk (due to the insurance effect).

6 Empirical implications and conclusions

In this section, we summarize our main findings from an empirical perspective, reconcile our results with a broad range of largely U.S.-based empirical studies, formulate novel empirical predictions, and conclude. To convey our model's empirical implications, we clarify the terminology by reinterpreting some equilibrium strategies we obtain in our model. First, following Dye (1985) and Jung and Kwon (1988), the insider in our model discloses sufficiently favorable information ($x \geq \tau$), for which the price upon disclosure exceeds the nondisclosure price, and withholds some unfavorable information. As discussed in Section 4.2, this distinction of favorable and unfavorable information does not simply translate into the empirical notion of good news and bad news. Instead, when compared with the expected market price, the threshold for the disclosure of sufficiently favorable information is always below the benchmark price, implying that the disclosure of sufficiently favorable information includes disclosure of all good news and weakly bad news. In addition, the insider always withholds intermediately bad news for which she does not anticipate litigation ($x \in (\rho, \tau)$) and, under some circumstances, discloses some very bad news to avert litigation, that is, $x \in (\theta, \rho]$.

This provides enough context to elaborate on a first association in our model that corresponds to the evidence of several empirical papers. If the penalty incurred by the insider as a result of successful litigation is large enough ($k > \underline{k}$), then she discloses information for which plaintiff investors and the attorney would rationally litigate, namely for very bad news. Since disclosure mitigates any legal claim, there is no basis for litigation for these information realizations. This litigation-prevention argument for disclosure of bad news goes back to Skinner (1994, 1997) and comports with the deterrence effect described by Becker (1968). Further corraborating evidence on the negative impact of bad news disclosures on litigation is also provided by Field et al. (2005) and Donelson et al. (2012), among others. As for the impact of litigation on disclosure, changes in litigation risk affect the deterrence effect in a particular way, giving rise to the following prediction.

Prediction 1 *Decreasing litigation risk leads to less disclosure of very bad news.*

Consistent with theoretical studies on litigation in accounting (e.g., Hillegeist 1999; Laux and Stocken 2012; Dye 2017), litigation has another effect in equilibrium, an insurance effect per Arrow (1965). Upon nondisclosure, investors know that they may have an opportunity to sue and be compensated for their damages, leading to a higher nondisclosure price as long as litigation occurs in equilibrium ($k < \bar{k}$). This insurance effect has not been intensively studied in the empirical literature but is supported by the evidence of Ali and Kallapur (2001). They study the stock market reaction to the Private Securities Litigation Reform Act (PSLRA) in 1995, which is commonly believed to have weakened shareholder litigation rights, and find a negative average market reaction.[26]

[26] Johnson et al. (2000) find an opposite result, but, as Ali and Kallapur (2001) argue, this arises largely from confounding events. Further supporting evidence that litigation helps determine price formation is documented, for example, by Griffin et al. (2004).

A change in litigation risk affects the insurance effect in a subtle way. Less litigation implies that investors' expected damage compensation decreases and they consequently price protect more, resulting in a lower nondisclosure price, which leads to more disclosure of weakly bad news.

Prediction 2 *Decreasing litigation risk leads to more disclosure of weakly bad news.*

More generally, our study suggests that empirical research on the impact of litigation risk on corporate disclosure should attempt to distinguish between weakly, intermediately, and very bad news, for which different predictions obtain. While changes in very bad news are primarily driven by the deterrence effect, changes in weakly bad news provide evidence for the existence of the less studied insurance effect.

Another set of influential empirical studies examines the average market reactions to bad news and good news to infer disclosure behavior (e.g., Skinner 1994; Kothari et al. 2009; Baginski et al. 2018). Skinner (1994) documents that, in the United States, the average market reaction to bad news disclosures is larger than to good news disclosures. He interprets this as evidence of the deterrence effect of litigation. Yet this empirical finding seemingly contradicts another of his observations, specifically, that bad news is more frequently conveyed in the less precise form of qualitative disclosures, whereas good news is more frequently disclosed quantitatively. All else equal, this would imply that good news should yield a stronger market reaction. In addition, the empirical finding of asymmetric market reactions is also interpreted somewhat heterogeneously in the empirical literature. For instance, Kothari et al. (2009) show that the asymmetric market reaction regularity is evidence of firms being more likely to disclose good news than bad news.

Our theory can help resolve the seemingly contradictory evidence. We provide conditions under which the market on average reacts more to bad news than to good news, holding information quality fixed. In particular, we show that this obtains if both insider penalties and litigation risk are sufficiently high (Proposition 1). The mechanism underlying these conditions is that the deterrence effect of litigation is strong enough to induce disclosure of very bad news. However, litigation is still imperfect because it is costly, so there is nondisclosure of intermediately bad news, another important requirement for this regularity to arise.

While we do not formally consider the differential precision of good and bad news disclosure, the outlined disclosure pattern partially explains why the average market reaction to bad news is larger than to good news, which, together with the results of Trueman (1997), resolves the contradictory evidence of Skinner (1994). Overall we provide a theoretical backing for the inference drawn by Skinner (1994). At the same time, the observation of Kothari et al. (2009) of a more timely disclosure of good news than bad also holds, implying that the inferences drawn by Skinner (1994) and Kothari et al. (2009) are not mutually exclusive. In fact, they both need to be present for the asymmetric market reactions regularity to occur.

Our analysis gives rise to another prediction on the average market reactions to good and bad news disclosures.

Prediction 3 *For firms facing low litigation risk, the average market reaction to good news is larger than to bad news.*

This prediction represents a falsification test and aims to verify whether private litigation is indeed the impetus for the widely documented asymmetric market reactions regularity. Our model predicts that the average market reaction to bad news is lower than to good news for a sample of firms that face low litigation risk. Such a sample could be drawn from the United States as firm-level litigation risk varies with factors such as industry classification (Kim and Skinner 2012), state of incorporation (Bourveau et al. 2018), and the circuit in which a firm is headquartered (Huang et al. 2020). Alternatively one might compare disclosure practices across a global sample (e.g., Tsang et al. 2019) and utilize differences in investor protection across countries (La Porta et al. 2002).

So far, our discussion has focused on the effects of litigation on the disclosure of different types of bad news. However, a large set of empirical papers studies the impact of litigation risk on overall disclosure. Baginski et al. (2002) provide a cross-sectional comparison of the arguably more litigious environment in the United States with the less litigious environment in Canada and find that Canadian firms disclose more. Other studies examine the impact of regulatory events that arguably changed the litigation risk of disclosure. Such events include the PSLRA, the staggered adoption of UD laws between 1989 and 2005, changes in the Ninth Circuit Court of Appeals in 1999, and the Morrison v. National Australia Bank Supreme Court ruling in 2010 in the United States. The evidence in these studies is mixed. Johnson et al. (2001) and Bourveau et al. (2018) provide evidence of a negative effect of litigation risk on disclosure, whereas Naughton et al. (2019), Houston et al. (2019), and Huang et al. (2020) show a positive effect.

Our joint consideration of the deterrence and insurance effects of litigation enables us to potentially explain this mixed evidence. Recall that decreasing litigation risk implies that the insider discloses less very bad news, due to the deterrence effect, while at the same time disclosing more weakly bad news, due to the insurance effect. Which of these effects dominates depends on a range of factors (Corollary 2 and Lemma 1). The next prediction captures the essence of the conditions our theory identifies for each of the effects to dominate.

Prediction 4 *Decreasing litigation risk leads to more disclosure of bad news by insiders facing low litigation risk and high information asymmetry and to less disclosure of bad news by insiders either facing high litigation risk or small information asymmetry.*

The predictions derive from Lemma 1 (ii) and (iii). It is important to emphasize that a requirement for disclosure to increase is that *both* litigation risk be low and information asymmetry be high, whereas for disclosure to decrease requires that *either* litigation risk be high *or* information asymmetry be low. According to Kim et al. (2021), the level of information asymmetry can be proxied by the level of capital expenditure, as firms with large capital expenditures are more prone to obtaining proprietary information that is unavailable to investors.

Finally, we provide results on the implications of shareholder litigation for the incentives of firms to innovate. A common concern is that litigation discourages innovation and thus harms growth (e.g., Seligman 1994). Yet, counter to this common concern, we show that the threat of litigation can lead to *more* rather than less innovation if the insurance effect dominates the deterrence effect of litigation and this obtains if insider penalties are not too large.

As for empirical implications, we formulate the following empirical prediction on the effects of changes of litigation risk for innovation.

Prediction 5 *Decreasing litigation risk leads to more corporate innovation for insiders facing large penalties or low litigation risk and to less corporate innovation for insiders facing small penalties and high litigation risk.*

Prediction 5 highlights our result in Corollary 3 in that innovation is a nontrivial function of litigation risk. So far, we are aware of only one empirical study that provides evidence on the relation, namely the work of Lin et al. (2021). They study the impact of litigation risk on corporate innovation in the United States using the staggered adoption of UD laws, which are believed to have reduced litigation risk (Bourveau et al. 2018). They find that firms on average innovate more, implying a negative impact of litigation risk on corporate innovation. This is consistent with the first part of Prediction 5. However, our results also suggest that using subsamples consisting of high- and low-litigation risk firms and settings to empirically measure managers' perceived penalties from litigation could lead to more nuanced results.

While our theory generally reconciles well with a large set of arguments and empirical regularities on the litigation-disclosure association, it is not without limitations, opening up interesting avenues for future theoretical research. First, we consider a standard one-period model with one piece of relevant private information, which the entrepreneur can credibly and truthfully disclose at no direct cost and which is later publicly observed. Using a noisy signal should not alter the main economic effects we study. However, considering an extension in which the entrepreneur obtains noisy information while investors' later signal is more precise (or vice versa) may be interesting, as the insider would be uncertain about future litigation and may therefore internalize both economic effects for any observed signal realization. Second, managers have discretion not only over whether to disclose but also when, how precise to be, and whether to bias their disclosures (Trueman 1990; Einhorn and Ziv 2012), which may affect firms' and managers' liability in court.

Third, we assume that the insiders' penalties are exogenously given, noting that they might arise from detrimental career outcomes and other reputational concerns. As such, they may be endogenously determined by a mechanism (e.g., labor markets) that may use information produced by litigation. Then the penalties might ultimately be functions of other exogenous variables, such as the attorney's legal cost.[27] Fourth, in line with the literature, we consider a setting with risk-neutral pricing absent private information. Yet litigation rights may have nontrivial effects on privately informed trading, which then also influence price formation and the strength of managerial information distortion incentives (Schantl 2022). Lastly, we do not distinguish between litigation that proceeds to trial and out-of-court settlements. We therefore do not consider the economics of settlement negotiations (e.g., Bebchuk 1984). We leave these and other considerations to future research.

[27] See Marinovic and Povel (2017) for a study of inference in labor markets in a contracting setting.

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Appendix

Proof of Theorem 1

The model solution is derived in the body of the paper. Here we shall focus on establishing equilibrium uniqueness on a case-by-case basis.
Case $k < \underline{k}$. Rewriting the conditions (10) and (2) using $P_{ND} = \tau - w$ from (3), we define the following equilibrium conditions:

$$g_\tau^S(\tau,\rho) \equiv pF(\tau)E\left[\tilde{x}|\tilde{x}<\tau\right] + (1-p)\mu + \gamma pF(\rho)\left(\tau - E\left[\tilde{x}|\tilde{x}\leq\rho\right]\right) - \tau\left[pF(\tau)+(1-p)\right],$$
$$g_\rho^S(\tau,\rho) \equiv \tau - \rho - \tfrac{c}{(1-\gamma)p}.$$

Setting $g_\tau^S(\tau,\rho)=0$ and $g_\rho^S(\tau,\rho)=0$ implicitly defines τ and ρ.
To establish equilibrium uniqueness, we first consider the following limits:

$$\lim_{\tau\to\underline{x}} g_\tau^S(\tau,\rho) \triangleq \lim_{\tau\to\underline{x},\rho\to\underline{x}} g_\tau^S(\tau,\rho) = (1-p)(\mu-\underline{x}) > 0,$$
$$\lim_{\tau\to\mu} g_\tau^S(\tau,\rho) = -p\tfrac{1}{2}\left(\mu - E\left[\tilde{x}|\tilde{x}<\mu\right]\right) + \gamma pF(\rho)\left(\mu - E\left[\tilde{x}|\tilde{x}\leq\rho\right]\right) < 0,$$
$$\lim_{\tau\to\overline{x}} g_\tau^S(\tau,\rho) = -\left(\overline{x}-\mu\right) + \gamma pF(\rho)\left(\overline{x} - E\left[\tilde{x}|\tilde{x}\leq\rho\right]\right) < 0,$$
$$\lim_{\rho\to\underline{x}} g_\rho^S(\tau,\rho) = \underline{\tau} - \underline{x} - \tfrac{c}{(1-\gamma)p},$$
$$\lim_{\rho\to\overline{x}} g_\rho^S(\tau,\rho) \triangleq \lim_{\tau\to\overline{x},\rho\to\overline{x}} g_\rho^S(\tau,\rho) = -\tfrac{c}{(1-\gamma)p} < 0.$$

For unbounded distributions ($\underline{x} \to -\infty$), the limit $\lim_{\rho\to\underline{x}} g_\rho^S(\tau,\rho)$ is unambigously positive, whereas, for bounded distributions ($\underline{x} > -\infty$), the limit is positive if

$$c < \overline{c} \equiv (1-\gamma)p(\underline{\tau} - \underline{x}),$$

where $\underline{\tau}$ is the unique positive root of the equation

$$\underline{\tau} = \frac{pF(\underline{\tau})E\left[\tilde{x}|\tilde{x} < \underline{\tau}\right] + (1-p)\mu}{pF(\underline{\tau}) + (1-p)},$$

which is independent of c.

Second, we define the Jacobian matrix (the matrix of first-order partials) as follows:

$$J^S \equiv \begin{pmatrix} \frac{\partial g_\tau^S(\tau,\rho)}{\partial \tau} & \frac{\partial g_\tau^S(\tau,\rho)}{\partial \rho} \\ \frac{\partial g_\rho^S(\tau,\rho)}{\partial \tau} & \frac{\partial g_\rho^S(\tau,\rho)}{\partial \rho} \end{pmatrix},$$

where

$$\frac{\partial g_\tau^S(\tau,\rho)}{\partial \tau} = -p\left[F(\tau) - \gamma F(\rho)\right] - (1-p) < 0,\ \frac{\partial g_\tau^S(\tau,\rho)}{\partial \rho} = \gamma p f(\rho)(\tau-\rho) > 0,$$
$$\frac{\partial g_\rho^S(\tau,\rho)}{\partial \tau} = 1 > 0,\ \frac{\partial g_\rho^S(\tau,\rho)}{\partial \rho} = -1 < 0.$$

The determinant of J^S is

$$\det(J^S) = \frac{\partial g_\tau^S(\tau,\rho)}{\partial \tau}\cdot\frac{\partial g_\rho^S(\tau,\rho)}{\partial \rho} - \frac{\partial g_\tau^S(\tau,\rho)}{\partial \rho}\cdot\frac{\partial g_\rho^S(\tau,\rho)}{\partial \tau}$$
$$= (1-\gamma)pF(\tau) + (1-p) + \gamma p(\tau-\rho)\left[\frac{F(\tau)-F(\rho)}{\tau-\rho} - f(\rho)\right],$$

Applying the mean value theorem, the term $\left[\frac{F(\tau)-F(\rho)}{\tau-\rho} - f(\rho)\right] \geq 0$ because $F(x)$ is weakly convex for all $x < \mu$ for weakly unimodal and symmetric $f(x)$ and $\rho < \tau < \mu$. The reason is that $\lim_{\tau\to\rho} \frac{F(\tau)-F(\rho)}{\tau-\rho} = f(\rho)$ and therefore $\frac{F(\tau)-F(\rho)}{\tau-\rho} \geq f(\rho)$ for $\tau > \rho$.

This establishes that the determinant is positive. It follows that, by the implicit function theorem, the equilibrium in the case of $k < \underline{k}$ is unique.

Case $\underline{k} \leq k < \min\{\bar{k}, \infty\}$. Similar to the case of $k < \underline{k}$, we insert $P_{ND} = \tau - w$ into (10), (2), and (5), and define the following equilibrium conditions:

$$g_\tau^M(\tau,\rho,\theta) \equiv pF(\theta)\left\{E\left[\tilde{x}|\tilde{x} < \theta\right] + \gamma\left(\tau - E\left[\tilde{x}|\tilde{x} \leq \theta\right]\right)\right\} + p\left[F(\tau) - F(\rho)\right]E\left[\tilde{x}|\rho < \tilde{x} < \tau\right]$$
$$+(1-p)\mu - \tau\left\{p\left\{F(\theta) + \left[F(\tau) - F(\rho)\right]\right\} + (1-p)\right\},$$
$$g_\rho^M(\tau,\rho,\theta) \equiv \tau - \rho - \frac{c}{p(1-\gamma)},$$
$$g_\theta^M(\tau,\rho,\theta) \equiv \tau - \theta - k.$$

Setting $g_\tau^M(\tau,\rho,\theta) = 0$, $g_\rho^M(\tau,\rho,\theta) = 0$, and $g_\theta^M(\tau,\rho,\theta) = 0$ implicitly defines τ, ρ, and θ.

The limits are

$$\lim_{\tau\to\underline{x}} g_\tau^M(\tau,\rho,\theta) \triangleq \lim_{\tau\to\underline{x},\rho\to\underline{x},\theta\to\underline{x}} g_\tau^M(\tau,\rho,\theta)=(1-p)(\mu-\underline{x})>0,$$
$$\lim_{\tau\to\mu} g_\tau^M(\tau,\rho,\theta)=-(1-\gamma)pF(\theta)\left(\mu-E\left[\tilde{x}|\tilde{x}<\theta\right]\right)-p\left[\tfrac{1}{2}-F(\rho)\right]\left(\mu-E\left[\tilde{x}|\rho<\tilde{x}<\mu\right]\right)<0,$$
$$\lim_{\tau\to\overline{x}} g_\tau^M(\tau,\rho,\theta)=-(1-\gamma)pF(\theta)\left(\overline{x}-E\left[\tilde{x}|\tilde{x}<\theta\right]\right)-p\left[1-F(\rho)\right]\left(\overline{x}-E\left[\tilde{x}|\rho<\tilde{x}<\overline{x}\right]\right)<0,$$
$$\lim_{\rho\to\underline{x}} \triangleq \lim_{\rho\to\underline{x},\theta\to\underline{x}} g_\rho^M(\tau,\rho,\theta)=\underline{\tau}-\underline{x}-\frac{c}{(1-\gamma)p}>0,$$
$$\lim_{\rho\to\overline{x}} g_\rho^M(\tau,\rho,\theta) \triangleq \lim_{\tau\to\overline{x},\rho\to\overline{x}} g_\rho^M(\tau,\rho,\theta)=-\frac{c}{(1-\gamma)p}<0.$$
$$\lim_{\theta\to\underline{x}} g_\theta^M(\tau,\rho,\theta)=\underline{\tau}-\underline{x}-k,$$
$$\lim_{\theta\to\overline{x}} g_\theta^M(\tau,\rho,\theta) \triangleq \lim_{\tau\to\overline{x},\rho\to\overline{x},\theta\to\overline{x}} g_\theta^M(\tau,\rho,\theta)=-k<0.$$

The limit $\lim_{\theta\to\underline{x}} g_\theta^M(\tau,\rho,\theta)$ is unambiguously positive for unbounded distributions, and, for bounded distributions, it is positive if $k<\overline{k}\equiv\underline{\tau}-\underline{x}$.

The determinant of the Jacobian matrix J^M in this case is

$$\begin{aligned}\det(J^M)=&\frac{\partial g_\tau^M(\tau,\rho,\theta)}{\partial\tau}\frac{\partial g_\rho^M(\tau,\rho,\theta)}{\partial\rho}\frac{\partial g_\theta^M(\tau,\rho,\theta)}{\partial\theta}+\frac{\partial g_\tau^M(\tau,\rho,\theta)}{\partial\rho}\frac{\partial g_\rho^M(\tau,\rho,\theta)}{\partial\theta}\frac{\partial g_\theta^M(\tau,\rho,\theta)}{\partial\tau}\\&+\frac{\partial g_\tau^M(\tau,\rho,\theta)}{\partial\theta}\frac{\partial g_\rho^M(\tau,\rho,\theta)}{\partial\tau}\frac{\partial g_\theta^M(\tau,\rho,\theta)}{\partial\rho}-\frac{\partial g_\tau^M(\tau,\rho,\theta)}{\partial\tau}\frac{\partial g_\rho^M(\tau,\rho,\theta)}{\partial\theta}\frac{\partial g_\theta^M(\tau,\rho,\theta)}{\partial\rho}\\&-\frac{\partial g_\tau^M(\tau,\rho,\theta)}{\partial\rho}\frac{\partial g_\rho^M(\tau,\rho,\theta)}{\partial\tau}\frac{\partial g_\theta^M(\tau,\rho,\theta)}{\partial\theta}-\frac{\partial g_\tau^M(\tau,\rho,\theta)}{\partial\theta}\frac{\partial g_\rho^M(\tau,\rho,\theta)}{\partial\rho}\frac{\partial g_\theta^M(\tau,\rho,\theta)}{\partial\tau}\\=&-\left\{(1-\gamma)p\left[F(\theta)+f(\theta)(\tau-\theta)\right]+p(\tau-\rho)\left[\frac{F(\tau)-F(\rho)}{\tau-\rho}-f(\rho)\right]+(1-p)\right\},\end{aligned}$$

where

$$\frac{\partial g_\tau^M(\tau,\rho,\theta)}{\partial\tau}=-p\left\{(1-\gamma)F(\theta)+\left[F(\tau)-F(\rho)\right]\right\}-(1-p)<0,$$
$$\frac{\partial g_\tau^M(\tau,\rho,\theta)}{\partial\rho}=pf(\rho)(\tau-\rho)>0,\ \frac{\partial g_\tau^M(\tau,\rho,\theta)}{\partial\theta}=-(1-\gamma)pf(\theta)(\tau-\theta)<0,$$
$$\frac{\partial g_\rho^M(\tau,\rho,\theta)}{\partial\tau}=1>,\ \frac{\partial g_\rho^M(\tau,\rho,\theta)}{\partial\rho}=-1<0,\ \frac{\partial g_\rho^M(\tau,\rho,\theta)}{\partial\theta}=0,$$
$$\frac{\partial g_\theta^M(\tau,\rho,\theta)}{\partial\tau}=1>0,\ \frac{\partial g_\theta^M(\tau,\rho,\theta)}{\partial\rho}=0,\ \frac{\partial g_\theta^M(\tau,\rho,\theta)}{\partial\theta}=-1<0.$$

As in the case $k<\underline{k}$, $\left[\frac{F(\tau)-F(\rho)}{\tau-\rho}-f(\rho)\right]\geq 0$ as per the mean value theorem. Therefore $\det(J^M)<0$, and the equilibrium in case of $k<\underline{k}\leq k<\min\{\overline{k},\infty\}$ is unique.

Case $k\geq\min\{\overline{k},\infty\}$. For distributions bounded from below ($\underline{x}>-\infty$), a third case obtains if penalties are sufficiently large ($k\geq\overline{k}$). The equilibrium is captured by the following set of conditions, which are derived using the same steps as in the previous two cases:

$$g_\tau^L(\tau,\rho)\equiv p\left[F(\tau)-F(\rho)\right]E\left[\tilde{x}|\rho<\tilde{x}<\tau\right]+(1-p)\mu-\tau\left\{p\left[F(\tau)-F(\rho)\right]+(1-p)\right\},$$
$$g_\rho^L(\tau,\rho)\equiv(\tau-\rho)-\frac{c}{(1-\gamma)p}.$$

$g_\tau^L(\tau,\rho)=0$ and $g_\rho^L(\tau,\rho)=0$ implicitly define τ and ρ.

The limits are

$$\begin{aligned}
\lim_{\tau\to\underline{x}} g_\tau^L(\tau,\rho) &\triangleq \lim_{\tau\to\underline{x},\rho\to\underline{x}} g_\tau^L(\tau,\rho) = (1-p)(\mu-\underline{x}) > 0,\\
\lim_{\tau\to\mu} g_\tau^L(\tau,\rho) &= -p\left[\tfrac{1}{2}-F(\rho)\right]\left(\mu - E\left[\tilde{x}|\rho<\tilde{x}<\mu\right]\right) < 0,\\
\lim_{\tau\to\overline{x}} g_\tau^L(\tau,\rho) &= -p\left[1-F(\rho)\right]\left(\overline{x} - E\left[\tilde{x}|\rho<\tilde{x}<\overline{x}\right]\right) - (1-p)(\overline{x}-\mu) < 0,\\
\lim_{\rho\to\underline{x}} g_\rho^L(\tau,\rho) &= \underline{\tau} - \underline{x} - \tfrac{c}{(1-\gamma)p} > 0,\\
\lim_{\rho\to\overline{x}} g_\rho^L(\tau,\rho) &\triangleq \lim_{\tau\to\overline{x},\rho\to\overline{x}} g_\rho^L(\tau,\rho) = -\tfrac{c}{(1-\gamma)p} < 0.
\end{aligned}$$

The determinant of the respective Jacobian matrix J^L is

$$\begin{aligned}
\det(J^L) &= \tfrac{\partial g_\tau^L(\tau,\rho)}{\partial\tau}\tfrac{\partial g_\rho^L(\tau,\rho)}{\partial\rho} - \tfrac{\partial g_\tau^L(\tau,\rho)}{\partial\rho}\tfrac{\partial g_\rho^L(\tau,\rho)}{\partial\tau}\\
&= (1-p) + p\,(\tau-\rho)\left[\tfrac{F(\tau)-F(\rho)}{\tau-\rho} - f(\rho)\right],
\end{aligned}$$

where

$$\begin{aligned}
\tfrac{\partial g_\tau^L(\tau,\rho)}{\partial\tau} &= -\left\{p\left[F(\tau)-F(\rho)\right]+(1-p)\right\} < 0,\ \tfrac{\partial g_\tau^L(\tau,\rho)}{\partial\rho} = pf(\rho)\,(\tau-\rho) > 0,\\
\tfrac{\partial g_\rho^L(\tau,\rho)}{\partial\tau} &= 1 > 0,\ \tfrac{\partial g_\rho^L(\tau,\rho)}{\partial\rho} = -1 < 0.
\end{aligned}$$

Applying the mean value theorem, the determinant is positive, establishing the uniqueness of the equilibrium case $k \geq \min\{\bar{k}, \infty\}$.

Together, the three cases prove Theorem 1. □

Proofs of Corollaries 1 and 2 and Lemma 1

To prove the statements in Corollaries 1 and 2 and Lemma 1 and to prepare for the subsequent analysis, we first state the equilibrium conditions assuming the uniform distribution $U(0, 1)$. For the intermediate penalty case ($\underline{k} \leq k < \bar{k}$), the conditions are

$$\begin{aligned}
g_\tau^M(\tau,\rho,\theta) &\equiv p\theta\left\{\tfrac{\theta}{2}+\gamma\left(\tau-\tfrac{\theta}{2}\right)\right\} + p(\tau-\rho)\tfrac{\tau+\rho}{2}\\
&\quad +(1-p)\tfrac{1}{2} - \tau\left\{p\left\{\theta+(\tau-\rho)\right\}+(1-p)\right\},\\
g_\rho^M(\tau,\rho,\theta) &\equiv \tau-\rho-\tfrac{c}{(1-\gamma)p},\\
g_\theta^M(\tau,\rho,\theta) &\equiv \tau-\theta-k.
\end{aligned}$$

Simultanenously solving $g_\tau^M(\tau,\rho,\theta) = 0$, $g_\rho^M(\tau,\rho,\theta) = 0$, and $g_\theta^M(\tau,\rho,\theta) = 0$ for τ, ρ,and θ yields the following explicit solutions:

$$\begin{aligned}
\tau &= \tfrac{Q-(1-p)(1-\gamma)}{p(1-\gamma)^2},\\
\rho &= \tfrac{Q-(1-p)(1-\gamma)-c(1-\gamma)}{p(1-\gamma)^2},\\
\theta &= \tfrac{Q-(1-p)(1-\gamma)-kp(1-\gamma)^2}{p(1-\gamma)^2},
\end{aligned}$$

where $Q \equiv \sqrt{(1-\gamma)^2\left[(1-p\gamma)(1-p)+(1-\gamma)^2k^2p^2\right]-(1-\gamma)c^2} > 0$. In addition, the solution for the insurance premium is

$$w = \frac{\left[Q-(1-\gamma)(1-p)\right]^2-(1-\gamma)^4k^2p^2}{2(1-\gamma)^4p}.$$

For all comparative statics with respect to the parameters $s \in \{c, k\}$, we use a multivariable version of the implicit function theorem, which implies that the following conditions must be satisfied:

$$\begin{aligned}
\frac{\partial g_\tau^M(\tau,\rho,\theta)}{\partial\tau}\frac{d\tau}{ds}+\frac{\partial g_\tau^M(\tau,\rho,\theta)}{\partial\rho}\frac{d\rho}{ds}+\frac{\partial g_\tau^M(\tau,\rho,\theta)}{\partial\theta}\frac{d\theta}{ds}&=-\frac{\partial g_\tau^M(\tau,\rho,\theta)}{\partial s},\\
\frac{\partial g_\rho^M(\tau,\rho,\theta)}{\partial\tau}\frac{d\tau}{ds}+\frac{\partial g_\rho^M(\tau,\rho,\theta)}{\partial\rho}\frac{d\rho}{ds}+\frac{\partial g_\rho^M(\tau,\rho,\theta)}{\partial\theta}\frac{d\theta}{ds}&=-\frac{\partial g_\rho^M(\tau,\rho,\theta)}{\partial s},\\
\frac{\partial g_\theta^M(\tau,\rho,\theta)}{\partial\tau}\frac{d\tau}{ds}+\frac{\partial g_\theta^M(\tau,\rho,\theta)}{\partial\rho}\frac{d\rho}{ds}+\frac{\partial g_\theta^M(\tau,\rho,\theta)}{\partial\theta}\frac{d\theta}{ds}&=-\frac{\partial g_\theta^M(\tau,\rho,\theta)}{\partial s}.
\end{aligned}$$

Simultaneously solving for $\frac{d\tau}{ds}$, $\frac{d\rho}{ds}$, and $\frac{d\theta}{ds}$ yields

$$\begin{aligned}
\frac{d\tau}{ds}=&\left[-\frac{1}{\det(J^M)}\right]\Bigg\{\frac{\partial g_\tau^M(\tau,\rho,\theta)}{\partial s}\left[\frac{\partial g_\rho^M(\tau,\rho,\theta)}{\partial\rho}\frac{\partial g_\theta^M(\tau,\rho,\theta)}{\partial\theta}-\frac{\partial g_\rho^M(\tau,\rho,\theta)}{\partial\theta}\frac{\partial g_\theta^M(\tau,\rho,\theta)}{\partial\rho}\right]\\
&+\frac{\partial g_\rho^M(\tau,\rho,\theta)}{\partial s}\left[\frac{\partial g_\tau^M(\tau,\rho,\theta)}{\partial\theta}\frac{\partial g_\theta^M(\tau,\rho,\theta)}{\partial\rho}-\frac{\partial g_\tau^M(\tau,\rho,\theta)}{\partial\rho}\frac{\partial g_\theta^M(\tau,\rho,\theta)}{\partial\theta}\right]\\
&+\frac{\partial g_\theta^M(\tau,\rho,\theta)}{\partial s}\left[\frac{\partial g_\tau^M(\tau,\rho,\theta)}{\partial\rho}\frac{\partial g_\rho^M(\tau,\rho,\theta)}{\partial\theta}-\frac{\partial g_\tau^M(\tau,\rho,\theta)}{\partial\theta}\frac{\partial g_\rho^M(\tau,\rho,\theta)}{\partial\rho}\right]\Bigg\},\\
\frac{d\rho}{ds}=&\left[-\frac{1}{\det(J^M)}\right]\Bigg\{\frac{\partial g_\tau^M(\tau,\rho,\theta)}{\partial s}\left[\frac{\partial g_\rho^M(\tau,\rho,\theta)}{\partial\theta}\frac{\partial g_\theta^M(\tau,\rho,\theta)}{\partial\tau}-\frac{\partial g_\rho^M(\tau,\rho,\theta)}{\partial\tau}\frac{\partial g_\theta^M(\tau,\rho,\theta)}{\partial\theta}\right]\\
&+\frac{\partial g_\rho^M(\tau,\rho,\theta)}{\partial s}\left[\frac{\partial g_\tau^M(\tau,\rho,\theta)}{\partial\tau}\frac{\partial g_\theta^M(\tau,\rho,\theta)}{\partial\theta}-\frac{\partial g_\tau^M(\tau,\rho,\theta)}{\partial\theta}\frac{\partial g_\theta^M(\tau,\rho,\theta)}{\partial\tau}\right]\\
&+\frac{\partial g_\theta^M(\tau,\rho,\theta)}{\partial s}\left[\frac{\partial g_\tau^M(\tau,\rho,\theta)}{\partial\theta}\frac{\partial g_\rho^M(\tau,\rho,\theta)}{\partial\tau}-\frac{\partial g_\tau^M(\tau,\rho,\theta)}{\partial\tau}\frac{\partial g_\rho^M(\tau,\rho,\theta)}{\partial\theta}\right]\Bigg\},\\
\frac{d\theta}{ds}=&\left[-\frac{1}{\det(J^M)}\right]\Bigg\{\frac{\partial g_\tau^M(\tau,\rho,\theta)}{\partial s}\left[\frac{\partial g_\rho^M(\tau,\rho,\theta)}{\partial\tau}\frac{\partial g_\theta^M(\tau,\rho,\theta)}{\partial\rho}-\frac{\partial g_\rho^M(\tau,\rho,\theta)}{\partial\rho}\frac{\partial g_\theta^M(\tau,\rho,\theta)}{\partial\tau}\right]\\
&+\frac{\partial g_\rho^M(\tau,\rho,\theta)}{\partial s}\left[\frac{\partial g_\tau^M(\tau,\rho,\theta)}{\partial\rho}\frac{\partial g_\theta^M(\tau,\rho,\theta)}{\partial\tau}-\frac{\partial g_\tau^M(\tau,\rho,\theta)}{\partial\tau}\frac{\partial g_\theta^M(\tau,\rho,\theta)}{\partial\rho}\right]\\
&+\frac{\partial g_\theta^M(\tau,\rho,\theta)}{\partial s}\left[\frac{\partial g_\tau^M(\tau,\rho,\theta)}{\partial\tau}\frac{\partial g_\rho^M(\tau,\rho,\theta)}{\partial\rho}-\frac{\partial g_\tau^M(\tau,\rho,\theta)}{\partial\rho}\frac{\partial g_\rho^M(\tau,\rho,\theta)}{\partial\tau}\right]\Bigg\}.
\end{aligned}$$

The determinant of the Jacobian matrix J^M is

$$\det(J^M) = -\{(1-\gamma)p\,[\theta+(\tau-\theta)]+(1-p)\} < 0,$$

so that the conditions are proportional to the expressions in the curly brackets. In addition, note that

$$\frac{\partial g_{\tau}^{M}(\tau,\rho,\theta)}{\partial c}=0,\ \frac{\partial g_{\rho}^{M}(\tau,\rho,\theta)}{\partial c}=-\frac{1}{(1-\gamma)p}<0,\ \frac{\partial g_{\theta}^{M}(\tau,\rho,\theta)}{\partial c}=0,$$
$$\frac{\partial g_{\tau}^{M}(\tau,\rho,\theta)}{\partial k}=0,\ \frac{\partial g_{\rho}^{M}(\tau,\rho,\theta)}{\partial k}=0,\ \frac{\partial g_{\theta}^{M}(\tau,\rho,\theta)}{\partial k}=-1<0.$$

Consequently, the first-order conditions of τ, ρ, and θ with respect to c are as follows:

$$\frac{d\tau}{dc}\propto-\left[\frac{\partial g_{\tau}^{M}(\tau,\rho,\theta)}{\partial\theta}\frac{\partial g_{\theta}^{M}(\tau,\rho,\theta)}{\partial\rho}-\frac{\partial g_{\tau}^{M}(\tau,\rho,\theta)}{\partial\rho}\frac{\partial g_{\theta}^{M}(\tau,\rho,\theta)}{\partial\theta}\right]=-p(\tau-\rho)<0,$$
$$\frac{d\rho}{dc}\propto-\left[\frac{\partial g_{\tau}^{M}(\tau,\rho,\theta)}{\partial\tau}\frac{\partial g_{\theta}^{M}(\tau,\rho,\theta)}{\partial\theta}-\frac{\partial g_{\tau}^{M}(\tau,\rho,\theta)}{\partial\theta}\frac{\partial g_{\theta}^{M}(\tau,\rho,\theta)}{\partial\tau}\right]=-\left\{p\left[(1-\gamma)\tau+(\tau-\rho)\right]+(1-p)\right\}<0,$$
$$\frac{d\theta}{dc}\propto-\left[\frac{\partial g_{\tau}^{M}(\tau,\rho,\theta)}{\partial\rho}\frac{\partial g_{\theta}^{M}(\tau,\rho,\theta)}{\partial\tau}-\frac{\partial g_{\tau}^{M}(\tau,\rho,\theta)}{\partial\tau}\frac{\partial g_{\theta}^{M}(\tau,\rho,\theta)}{\partial\rho}\right]=-p(\tau-\rho)<0.$$

The first-order conditions of DL, ALR and PLR with respect to c further are

$$\frac{dDL}{dc}=\frac{\partial DL}{\partial\tau}\frac{d\tau}{dc}+\frac{\partial DL}{\partial\rho}\frac{d\rho}{dc}+\frac{\partial DL}{\partial\theta}\frac{d\theta}{dc}=p\left[-\frac{d\tau}{dc}+\left(\frac{d\rho}{dc}-\frac{d\theta}{dc}\right)\right]\propto\Gamma_{DL},$$
$$\frac{dALR}{dc}=\frac{\partial ALR}{\partial\tau}\frac{d\tau}{dc}+\frac{\partial ALR}{\partial\rho}\frac{d\rho}{dc}+\frac{\partial ALR}{\partial\theta}\frac{d\theta}{dc}=\frac{d\theta}{dc}<0,$$
$$\frac{dPLR}{dc}=\frac{\partial PLR}{\partial\tau}\frac{d\tau}{dc}+\frac{\partial PLR}{\partial\rho}\frac{d\rho}{dc}+\frac{\partial PLR}{\partial\theta}\frac{d\theta}{dc}=\frac{d\rho}{dc}<0,$$

respectively. Here, $\Gamma_{DL}\equiv p(\tau-\rho)-(1-\gamma)p\tau-(1-p)=\frac{c-Q}{(1-\gamma)}$, which has the following properties with respect to k:

$$\frac{d\Gamma_{DL}}{dk}=\frac{\partial\Gamma_{DL}}{\partial\tau}\frac{d\tau}{dk}+\frac{\partial\Gamma_{DL}}{\partial\rho}\frac{d\rho}{dk}+\frac{\partial\Gamma_{DL}}{\partial\theta}\frac{d\theta}{dk}=\gamma p\frac{d\tau}{dk}-p\frac{d\rho}{dk}=-\left[-\frac{1}{\det(J^{M})}\right](1-\gamma)^{2}p^{2}(\tau-\theta)<0,$$
$$\lim_{k\to\underline{k}}\Gamma_{DL}=\frac{c-\sqrt{(1-\gamma)^{2}(1-p)(1-p\gamma)-c^{2}\gamma(1-\gamma)}}{(1-\gamma)}>0,$$
$$\lim_{k\to\bar{k}}\Gamma_{DL}=\frac{c-\sqrt{(1-\gamma)^{2}\left\{(1-p\gamma)(1-p)+\frac{\left[(1-\gamma)(1-p)p-2c^{2}\right]^{2}}{(1-p)^{2}}\right\}-(1-\gamma)c^{2}}}{(1-\gamma)}.$$

It can be shown that $\lim_{k\to\bar{k}}\Gamma_{DL}<0$ if

$$p>p_{DL}\equiv\frac{(1+2\gamma)}{(1+\gamma)^{2}}$$

and

$$c_{DL}^{L}\equiv\sqrt{\frac{(1-\gamma)^{2}(1-p\gamma)(1-p)}{1+\gamma(1-\gamma)}}<c<c_{DL}^{H}$$
$$\equiv\sqrt{(1-\gamma)(1-p)\left[2-(1+\gamma)p\right]+(1-p)^{2}}-(1-p).$$

Therefore there must exist a unique threshold $k_{DL} \in (\underline{k}, \bar{k})$. If $p > p_{DL}$ and $c \geq c_{DL}^H$, then $\Gamma_{DL} > 0$; otherwise $\Gamma_{DL} < 0$. □

Proof of Proposition 1

The ex ante stock price $E[P]$ for the case with intermediate penalties is

$$\begin{aligned} E[P] &= \{pF(\theta) + p[F(\tau) - F(\rho)] + (1-p)\} P_{ND} + p[1-F(\tau)] E[P_D(\tilde{x})|\tilde{x} \geq \tau] \\ &+ p[F(\rho) - F(\theta)] E[P_D(\tilde{x})|\theta < \tilde{x} \leq \rho] = [p\theta + p(\tau - \rho) + (1-p)]\tau \\ &+ p\frac{(1-\tau^2)}{2} + p\frac{\rho^2 - \theta^2}{2} - w = \frac{1}{2} + p\gamma\theta\left(\tau - \frac{\theta}{2}\right) - w. \end{aligned}$$

The market reaction to disclosure is

$$P_D(x) - E[P] = x - w - E[P],$$

and it is straightforward to see that w cancels out in this difference as w is a sunk cost. To save notation, we therefore disregard w in the following proof.

The proof of Theorem 1 establishes that $\tau < \mu = 1/2$. Good news can now be defined as disclosures that lead to a positive market reaction,

$$P_D(x) - E[P] \geq 0 \Rightarrow x - E[P] \geq 0.$$

Since $E[P] > \frac{1}{2} > \tau$, it follows that good news is always disclosed. Therefore the magnitude of the average market reaction to good news is

$$E\left[|P_D(\tilde{x}) - E[P]|\,|P_D(\tilde{x}) \geq E[P]\right] = \frac{\int_{E[P]}^{1}(\tilde{x} - E[P])d\tilde{x}}{\int_{E[P]}^{1} 1d\tilde{x}} = \frac{1 - E[P]}{2}.$$

The average market reaction to bad news averages over weakly bad news ($x \in [\tau, E[P])$) and very but not extremely bad news ($x \in (\theta, \rho]$):

$$\begin{aligned} &E\left[|P_D(\tilde{x}) - E[P]|\,|\tau \leq \tilde{x} < E[P] \cup \theta < \tilde{x} \leq \rho\right] \\ &= \frac{\int_{\tau}^{E[P]}(E[P]-\tilde{x})d\tilde{x} + \int_{\theta}^{\rho}(E[P]-\tilde{x})d\tilde{x}}{\int_{\tau}^{E[P]} 1d\tilde{x} + \int_{\theta}^{\rho} 1d\tilde{x}} = \frac{\frac{(E[P]-\tau)^2}{2} + (\rho-\theta)\left\{E[P] - \frac{\rho+\theta}{2}\right\}}{E[P]-\tau+(\rho-\theta)}. \end{aligned}$$

The difference in average market reactions becomes

$$\begin{aligned} \Delta MR \equiv\; &E\left[|P_D(\tilde{x}) - E[P]|\,|\tau \leq \tilde{x} < E[P] \cup \theta < \tilde{x} \leq \rho\right] \\ &-E\left[|P_D(\tilde{x}) - E[P]|\,|P_D(\tilde{x}) \geq E[P]\right] \\ &= \frac{\frac{(E[P]-\tau)^2}{2} + (\rho - \theta)\left(E[P] - \frac{\rho+\theta}{2}\right)}{E[P] - \tau + (\rho - \theta)} - \frac{1 - E[P]}{2}. \end{aligned}$$

Inserting

$$E[P] = \frac{1}{2} + p\gamma\theta\left(\tau - \frac{\theta}{2}\right)$$

into ΔMR leads to

$$\Delta MR = \frac{\frac{1}{2}\left[\left(\frac{1}{2}-\tau\right)+p\gamma\theta\left(\tau-\frac{\theta}{2}\right)\right]^2+(\rho-\theta)\left[\left(\frac{1}{2}-\frac{\rho+\theta}{2}\right)+p\gamma\theta\left(\tau-\frac{\theta}{2}\right)\right]}{\left(\frac{1}{2}-\tau\right)+(\rho-\theta)+p\gamma\theta\left(\tau-\frac{\theta}{2}\right)} - \frac{\left[\frac{1}{2}-p\gamma\theta\left(\tau-\frac{\theta}{2}\right)\right]}{2}.$$

Using the implicit function theorem, the first-order condition of ΔMR with respect to k is

$$\frac{dMR}{dk} = \frac{\partial MR}{\partial\tau}\frac{d\tau}{dk} + \frac{\partial MR}{\partial\rho}\frac{d\rho}{dk} + \frac{\partial MR}{\partial\theta}\frac{d\theta}{dk}.$$

It is tedious but possible to show that $\frac{dMR}{dk} > 0$. In addition, note the following limits:

$$\lim_{k\to\underline{k}}\Delta MR = -\frac{(1-\tau)[1-p(1-\tau)]}{2} < 0,$$
$$\lim_{k\to\bar{k}}\Delta MR = \frac{(\frac{1}{2}-\tau)^2+\rho(1-\rho)}{1-2(\tau-\rho)} - \frac{1}{4}.$$

The upper limit $\lim_{k\to\bar{k}}\Delta MR$ can further be shown to be positive if

$$c < c_{MR} \equiv \frac{(1-\gamma)\left[\sqrt{1-p^2}-(1-p)\right]}{2}.$$

Taken together, there must exist a unique threshold $k_{MR} \in [\underline{k}, \bar{k})$, completing the proof of Proposition 1. □

Proof of Proposition 2

To prove whether $a(c \in (0, \bar{c}))$ is larger or smaller than $a(c = \bar{c}) = \frac{1}{2}$, note that the crucial term is

$$\Lambda_a \equiv \gamma\left(\tau - \frac{\rho}{2}\right) - k.$$

The properties of Λ_a with respect to k are

$$\begin{gathered}\frac{d\Lambda_a}{dk} = -(1-\gamma) - \frac{\gamma[p(1-\gamma)\theta+(1-p)]}{2[p(1-\gamma)\tau+(1-p)]} < 0, \\ \lim_{k\to\underline{k}} \Lambda_a \triangleq \lim_{k\to\underline{k},\theta\to\rho} \Lambda_a = \gamma\left(\tau - \frac{\rho}{2}\right) - \frac{c}{(1-\gamma)p}, \\ \lim_{k\to\bar{k}} \Lambda_a = -(1-\gamma)\tau < 0.\end{gathered}$$

Note that $\lim_{k\to\bar{k}} \Lambda_a < 0$ since $\bar{k} = \tau$. The lower limit $\lim_{k\to\underline{k}} \Lambda_a$ is positive if

$$c < c_a \equiv \gamma(1-\gamma)p\left(\underline{\tau} - \frac{\rho}{2}\right)$$

and negative otherwise, where c_a can be shown to be unique. Given that $c < c_a$, it further follows that there must exist a unique threshold $k_a \in [\underline{k}, \bar{k})$, completing the proof of Proposition 2. □

Proof of Corollary 3

We rewrite innovative effort as

$$a = \frac{1}{2} + p\theta\left[\gamma\left(\tau - \frac{\theta}{2}\right) - k\right] = \frac{1}{2} + p\theta\left[\gamma\left(\tau - \frac{\theta}{2}\right) - (\tau - \theta)\right].$$

Using the implicit function theorem, the first-order condition of a with respect to c is

$$\frac{da}{dc} \propto \Gamma_a^M \equiv (1-\gamma)\tau - \theta,$$

The properties of Γ_a^M with respect to c and k are

$$\begin{gathered}\lim_{c\to 0} \Gamma_a^M \triangleq \lim_{\rho\to\tau} \Gamma_a^M, \\ \lim_{c\to\bar{c}} \Gamma_a^M \triangleq \lim_{\rho\to 0,\theta\to 0} \Gamma_a^M = (1-\gamma)\tau > 0, \\ \frac{d\Gamma_a^M}{dc} = \frac{\gamma(\tau-\rho)}{(1-\gamma)[(1-\gamma)p\tau+(1-p)]} > 0. \\ \lim_{k\to\underline{k}} \Gamma_a^M \triangleq \lim_{\theta\to\rho} \Gamma_a^M, \\ \lim_{k\to\bar{k}} \Gamma_a^M \triangleq \lim_{\theta\to 0} \Gamma_a^M = (1-\gamma)\tau > 0, \\ \frac{d\Gamma_a^M}{dk} = \frac{(1-\gamma)p[(1-\gamma)\tau+\gamma\theta]+(1-p)}{[(1-\gamma)p\tau+(1-p)]} > 0.\end{gathered}$$

It is straightforward to show that $\lim_{c\to 0} \Gamma_a^M$ is negative for sufficiently small k and that $\lim_{k\to\underline{k}} \Gamma_a^M$ is negative for sufficiently small c. From this, it follows that there must exist two thresholds $k_{\Delta a} \in [\underline{k}, \bar{k})$ and $c_{\Delta a} \in (0, \bar{c})$ such that only if $k < k_{\Delta a}$ and $c < c_{\Delta a}$, $\frac{da}{dc} < 0$. □

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