Liability for Non-Disclosure in Equity Financing

Law Working Paper N° 678/2023
July 2024

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ECGI Working Paper Series in Law

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Abstract

A privately-informed entrepreneur may withhold material information from prospective investors who may sue the firm ex post for (alleged) non-disclosure. Absent liability, the entrepreneur has an excessive incentive to withhold bad news and pursue socially-wasteful projects. Liability deters inefficient nondisclosure and prevents capital misallocation. Any damage award received by investors is partially offset by a reduction in equity value. Depending on the likelihood of court error and litigation cost, the socially-optimal damage award may be either zero or the minimum necessary for full deterrence. The private incentive to waive liability may be socially excessive or insufficient. Positive and normative implications are discussed.

Keywords: Equity Financing, IPO Liability, Non-Disclosure, Securities Litigation, Liability Waiver, Class Action Waiver

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June 26, 2024

Abstract

A privately-informed entrepreneur may withhold material information from prospective investors who may sue the firm ex post for (alleged) non-disclosure. Absent liability, the entrepreneur has an excessive incentive to withhold bad news and pursue socially-wasteful projects. Liability deters inefficient non-disclosure and prevents capital misallocation. Any damage award received by investors is partially offset by a reduction in equity value. Depending on the likelihood of court error and litigation cost, the socially-optimal damage award may be either zero or the minimum necessary for full deterrence. The private incentive to waive liability may be socially excessive or insufficient. Positive and normative implications are discussed.

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1 Introduction

On May 17, 2012, Facebook went public by selling more than 421 million shares of common stock at $38 per share to public investors on the Nasdaq and raised about $16 billion from the investors. Unlike many other initial public offerings that experience an initial price surge, Facebook's stock price declined shortly after the initial public offering (IPO), hitting a low of $18. It took more than a year for the stock price to rebound to the IPO price of $38. Many public investors, who bought Facebook's shares at the IPO or shortly after, were quite unhappy and brought class action suits against the company under the US Securities Act, claiming that Facebook failed to disclose the fact that more users were using their mobile phones to access Facebook's websites instead of their computers, and the company's advertising revenues were lower than as described in the IPO documents.[1] After more than five years of pre-trial procedures, immediately before the case was to go to trial, the litigants agreed to settle the case for $35 million in 2018.[2]

As the Facebook story demonstrates, when a company raises capital by selling securities to outside investors, the US securities laws require the company to disclose relevant material information it possesses to the prospective investors. In case the company fails to do so, the investors can bring suit against the company to recover damages. Presumably, such a liability regime ensures that the outside investors will receive necessary information from the company to make an informed decision as to whether to purchase the offered security. At the same time, though, critics have argued that the private enforcement regime, especially the class action system, is too costly and encourages indiscriminate lawsuits against even innocent companies.[3] To what extent does such a liability regime induce the company to disclose relevant material information to the investors? Does liability lead to a more efficient allocation of capital? Should we allow firms to design their own liability systems, say through a mandatory individual arbitration provision, or to opt out of liability altogether?

The paper presents a simple, stylized model of a resource-constrained entrepreneur who seeks outside funding to pursue a risky business venture. The capital market is competitive and investors are sophisticated. Before raising the necessary capital,

[1] See Atkins (2018) and Graf (2018).

[2] Id. Out of $35 million settlement, plaintiff's attorneys received almost $14 million as fees and costs. See Graf (2018). Although the size of settlement in the Facebook case was exceptionally small compared to the size of the IPO and the potential recovery, according to Lowry and Shu (2002), the average size of settlement in their sample was about 11% of the total proceeds raised in IPOs.

[3] See Scott and Silverman (2013). They argue that most of the securities class actions are without merit and the companies should be allowed to bar securities class actions through a mandatory non-class arbitration provision in their charters or bylaws.

the entrepreneur may observe a private signal revealing the project's future cash flow (high or low). High-value projects are socially worthwhile while low-value projects are socially wasteful. Both the arrival of the signal and its contents are privately observed by the entrepreneur. If the entrepreneur learns that the value is high, the entrepreneur discloses the good news to the investors and lowers the cost of capital. If the entrepreneur learns that the value is low, on the other hand, the entrepreneur is tempted to withhold the bad news and masquerade as having an "average" project to secure funding. Since low-value projects are socially wasteful, withholding bad news and raising outside funding leads to a misallocation of capital and a welfare loss.

Firm liability for non-disclosure can deter the low-value entrepreneur and prevent the capital misallocation. After the cash flows are realized and evidence mounts that the entrepreneur hid material information from investors, the investors may sue *the firm* for damages. Litigation is costly (with lawyers capturing some rent) and the court may find innocent entrepreneurs liable (false positives). Since the damage award is paid by the firm (and not the entrepreneur), any damages award received by the investors is offset in part by the reduced value of their equity stake in the firm.[4] Notwithstanding the complexities, the analysis shows that when the damages award is below a threshold, the low-value entrepreneur is either partially deterred (randomizes between pursuing and abandoning the low-value projects) or not deterred at all. Deterrence is stronger when the entrepreneur has a larger personal stake in the venture and when the likelihood that the entrepreneur is privately informed is larger.[5] When the damage award is above a threshold, on the other hand, full deterrence is obtained.

Our analysis also delivers normative insights. We show that the socially-optimal liability rule involves either the minimum level necessary to achieve full deterrence or no liability at all. As in standard models of litigation, if the social cost of litigation (including the lawyers' opportunity cost of time) outweighs the deterrence benefit of liability (more efficient capital allocation), it is socially desirable to eliminate liabil-

[4]This circularity is noted by Coffee (2006). As we show in Appendix B, deterrence is easier to obtain with smaller damages and the social welfare is (weakly) higher if investors can sue the entrepreneur directly for non-disclosure. Furthermore, with smaller damages, because the amount of rent captured by lawyers is smaller in equilibrium, private incentive to opt into liability will be even stronger. Kraakman et al. (1994) consider derivative lawsuits against managers for misconduct but do not consider information disclosure. In a derivative suit, shareholders sue a third party (such as the corporation's director or officer) on behalf of the corporation and all recovery goes back to the corporation. Our setup is different on two important dimensions: (1) shareholders bring suit against the firm (not some third party); and (2) they get a direct recovery from the firm.

[5]If it is common knowledge that the entrepreneur has the private information, full unraveling occurs as in Grossman (1981) and Milgrom (1981) and we get full deterrence.

ity altogether.[6] However, if the adverse selection problem is severe, the deterrence benefit outweighs the cost and imposing liability to achieve full deterrence is socially optimal. Liability for non-disclosure is cost justified if and only if the proportion of entrepreneurs with bad news is above a threshold.

We then explore the private design of liability rules. Interestingly, the uninformed entrepreneur's private incentive to allow investor lawsuits can be either socially excessive or insufficient in equilibrium.[7] On the one hand, giving investors the option to litigate serves as a type of "warranty" and signals that the entrepreneur is not withholding any material information.[8] This lowers the uninformed entrepreneur's cost of capital at the expense of the low-value entrepreneur. Since the uninformed entrepreneur does not take into account the negative impact on the low-value entrepreneur's rents, there may be too many lawsuits (i.e., too much costly signaling) in equilibrium. On the other hand, because adjudication error can lead to non-meritorious lawsuits and lawsuits allow lawyers to capture rent (which is welfare neutral but costly from the entrepreneur's perspective), the entrepreneur may opt out of liability even though litigation is beneficial for society. In short, we cannot rely solely upon market self-regulation to choose the optimal liability regime.[9]

The paper is organized as follows. Section 2 presents a brief literature review. Section 3 presents a brief overview of the legal background for our analysis, focusing principally on the disclosure obligations and liability in an IPO setting. Section 4 presents a model that analyzes an entrepreneur's incentive to withhold negative information and characterizes the socially-optimal liability rule. Section 5 explores the private design of liability rules and the conditions under which the private incentive to opt out of liability (through a liability waiver) may be socially excessive or insufficient. Section 6 outlines the empirical predictions of the model. Section 7 concludes with thoughts for future research. All proofs are in Appendix A.[10]

[6]See Shavell (1982, 1997) on the private incentive to use the legal system.

[7]Because, in equilibrium, the low-value entrepreneur will mimic the uninformed entrepreneur, what matters is the uninformed entrepreneur's preferences over the liability system.

[8]See Spence (1977) and Grossman (1981) on warranties as signals of product quality.

[9]On the other hand, as we argue in the implications section, in contrast to a liability waiver, social and private incentives are more likely to be aligned with respect to federal forum provisions that require Section 11 lawsuits to be brought only in federal courts.

[10]Appendix B includes three extensions: (1) allowing investors to sell the stock before lawsuit; (2) two-sided litigation costs; and (3) holding the entrepreneur personally liable. With respect to entrepreneur liability, we show that deterrence is easier to obtain and the social welfare is higher. However, because the amount of rent captured by lawyers is smaller in equilibrium, the private incentive to waive liability will be weaker.

2 Literature Review

This paper extends the literature on the disclosure of information prior to the sale of an asset. Grossman (1981) and Milgrom (1981) introduced the famous unraveling result when sellers are privately informed about asset quality. Sellers of high quality assets have a clear incentive to disclose this information (to obtain a better selling price) and, as a consequence, sophisticated buyers draw adverse inferences when sellers *do not* disclose. Grossman and Hart (1981) explored the implications of full unraveling for disclosure laws in corporate takeovers.[11] Dye (1985), Farrell (1986), and Shavell (1994) showed that complete unraveling does not occur when buyers are uncertain as to whether the sellers actually have private information. In their analyses, sellers with low quality assets have an incentive to withhold the information from the market and pool with the uninformed types.[12] These papers all assumed that disclosure, if mandated, is perfectly enforced and that the seller does not retain an equity stake in the asset.

Dye (2017) explores a model where mandatory disclosure is imperfectly enforced. Our analysis differs from Dye's core model in several important respects. First, in Dye (2017), the asset sale is assumed to always takes place (and is efficient) and the seller simply chooses the disclosure strategy to maximize the sale price. Liability only affects the seller's equilibrium disclosure strategy.[13] In our analysis, liability for non-disclosure is socially valuable because it deters the entrepreneur from selling equity in socially-wasteful projects and avoids the misallocation of capital.

Second, in Dye (2017), the seller is personally liable for non-disclosure. In our

[11] Grossman and Hart concluded that "the commonly held view that firms withhold information (which is free to release) in order to mislead traders into giving them better terms is false." (p. 333)

[12] Shavell (1994) focused on the incentive of sellers to acquire information prior to a sale. Although mandatory disclosure may be socially desirable conditional on the seller acquiring the information, it may chill the collection of socially valuable information. Polinsky and Shavell (2012) showed that when sellers are strictly liable for consumer harms stemming from defective products, and can take precautions to reduce product risks, then mandatory and voluntary disclosure are equivalent.

[13] Dye (2017) Section 7 allows for inefficient delay and fractional ownership. Social welfare falls when the seller retains a larger fraction of the asset. In our model, increasing the seller's stake is socially efficient insofar as it deters sellers with low-value assets from participating. Trueman (1997) and Marinovic and Varas (2016) examine a manager's incentive to withhold bad information from the market and maximize the stock price, but, without any financing, non-disclosure itself does not lead to any welfare loss. Caskey (2014) develops a securities pricing model to explore the price effects of pending litigation, focusing on the role of litigation insurance. The damages received by investors is offset by a dilution of their equity stake. Caskey (2014) does not consider the misallocation of capital (there is no financing) or allowing the firm to design their own liability system. Spindler (2007) examines the put option feature of the liability regime and examines the entrepreneur's behavior post IPO.

analysis, *the firm itself* is liable for the damage payment, and the seller's accountability for non-disclosure is limited to their (endogenous) financial stake in the firm. Third, our analysis considers the possibility of false positives and the cost of litigation and the impact they have on disclosure and deterrence. Imperfections in the ex post verification process cause the private and social preferences over liability regimes to diverge.[14] These factors not only affect the optimal liability regime and social welfare but also the entrepreneur's and the social planner's incentive to waive liability.

Several scholars have also theoretically examined the impact on liability system on the securities markets, especially on the IPO market. Hughes and Thakor (1992), for instance, examine the idea of an underwriter deliberately under-pricing its stock at the IPO so as to avoid potential lawsuit ex post. In their analysis, over or under-pricing at IPO can happen because the underwriter can be either "myopic" or "nonmyopic" in making its pricing decision.[15] Evans and Sridhar (2002) investigate interactions among the financial market, product market, and shareholder lawsuits. Their model assumes that, even with low cash flow, the project has positive NPV. Laux and Stocken (2012) examine an entrepreneur raising capital to undertake a project and the impact of the entrepreneur's relative optimism compared to the outside investors. Their analysis assumes that the entrepreneur is personally liable for investor losses. Compared to the earlier literature, our paper allows for: (1) capital misallocation and deadweight loss; (2) firm liability and drop in equity value for plaintiff-shareholders; and, most importantly, (3) allowing firms to design their own liability systems. Particularly, with respect to (3), we are not aware of any earlier scholarship that has theoretically examined this issue.[16]

[14]Nan and Wen (2019) allow for possible welfare loss when an entrepreneur with a low-value project misreports and raises capital. In their analysis, ex post liability is a "penalty" to be paid personally by the entrepreneur and, because the size of the penalty depends on the updated belief of facing a low-value project, the penalty is independent of entrepreneur type and cannot achieve full deterrence. Similar to Dye (2017), they do not consider (1) the cost of litigation, including the rent being captured by other players, such as the lawyers, (2) the possibility of choosing an optimal liability regime, including a liability waiver, or (3) the possible divergence of social versus private interests over the liability regime.

[15]In an earlier paper, Hughes (1986) allows for a privately informed firm to disclose information to an underwriter who, in turn, verifies the disclosure. Although the analysis assumes that the firm is raising capital for a project, the project is assumed to be positive NPV (no deadweight loss) and any liability is born by the entrepreneur. Alexander (1993) takes issue with Hughes and Thakor (1992) and argues that when we take into consideration the more complex legal issues, it is unlikely that the legal liability will lead to under-pricing of IPO shares.

[16]There also is a literature that examines optimal managerial compensation schemes in light of potential misreporting by executives. Acharya, John, and Sundaram (2000) argue that resetting strike prices on underwater executive stock options can motivate the executives ex post (in bad states) and this can possibly improve ex ante welfare. Goldman and Slezak (2006) analyze how

On the empirical side, Lowry and Shu (2002) examine the litigation risk on IPO under-pricing and show that firms with higher legal exposure tend to under-price their offerings more and also that under-pricing decreases the expected litigation costs.[17] Hanley and Hoberg (2012) examine IPO prospectuses and show that companies make a tradeoff between IPO underpricing and more disclosure as a potential hedge against litigation risk. Focusing on class action securities lawsuits, Scott and Silverman (2013) argue that the class action system has many deficiencies and we should allow firms to adopt mandatory individual arbitration when they go public. Our paper attempts to examine the issues of disclosure more closely and to shed new light on the optimal liability system, including whether allowing class action waivers can be socially beneficial.

3 Legal Background

The Securities and Exchange (SEC) Act of 1933, informally known as the "Truth in Securities Act," regulates the way that securities are offered and sold to investors. Before a company can sell stock to the public for the first time (an IPO), the company must file a registration statement with the SEC, secure its approval, and provide a prospectus to potential investors.[18] Ideally, the registration statement and prospectus provide detailed and accurate information, allowing the investors to make well-informed decisions about whether to purchase the security. To make sure the the company is providing accurate information to the investors, under section 11 of the Act, the company may be held liable to investors for any "material mistatement" or "material omission" in the registration statement or prospectus.[19]

pay-for-performance can induce executives to exert more effort but also to divert valuable resources to misrepresent performance, and shows that the optimal compensation contract will have a lower sensitivity. Bolton, Scheinkman, and Xiong (2006) show, when investors have heterogeneous beliefs and stock prices can deviate from underlying fundamentals, how short-term based compensation can be optimal by allowing the firm to sell more stock to future optimistic investors. Our paper abstracts from these internal agency problems and focuses instead on the asymmetric information problem between an entrepreneur and outside investors.

[17]Prior studies show little or no difference in returns in firms that were sued versus those who were not or little difference in characteristics among the cases that were filed. See Tinic (1988), Drake and Vetsuypens (1993), and Bohn and Choi (1996). See Ritter and Welch (2002) and Ritter (2011) for a more extensive review of the literature.

[18]Securities Act of 1933 §5. The prospectus is essentially the first part of the registration statement; the second part provides more detailed analysis of the business model, results of operations, and the future risks that investors face.

[19]Subsection 11(a) states: "in case any part of the registration statement...contained an untrue statement of a material fact or omitted to state a material fact required to be stated therein or necessary to make the statements therein not misleading, any person acquiring such security...may"

In order to prevail in a Section 11 case against a company, an investor needs to establish two things: (1) that the registration statement misstated or omitted material information; and (2) that they were harmed (e.g., that they sold the security for less than they paid).[20] Once these are established, liability against the company is strict rather than negligence based. In other words, to receive compensation, investors need not show that the company deliberately (or negligently) made misleading statements or omitted material information.[21] If the company is liable, then investors may collect damages that reflect the difference between the price that they paid for the security and the price when the suit is brought (or, if they sold the stock prior to the lawsuit, the price that they received).[22]

There are many concerns about the efficacy of the securities litigation system. In practice, since harmed investors are often numerous and dispersed, Section 11 claims (and securities claims more generally) are often pursued by class-action attorneys on behalf of plaintiffs. Critics have argued that litigation is expensive and error prone, enriches the attorneys at the expense of the investors, and fails to deter the behaviors the law seeks to control. For example, NERA Economic Consulting found that among all securities class actions between between 1991 and 2004, the ratio of settlement value to investor harm was at most 7.2% and, in many years, much lower. At the same time, plaintiffs' attorneys received, on average, 32% of the damages paid.[23] While previous studies have suggested that many, if not most, "securities-fraud class actions are, in fact, frivolous," empirical evidence suggests that companies do respond to potential liability when going public through, for example, the pricing

bring a lawsuit.

[20]Under Section 11, legal action must be brought within three years of the offering. Section 13 imposes a statute of limitations of one year after discovery of the misstatement. Also, if the investor was aware of the "material omission" or "material misstatement" at the time of the purchase, the investor cannot get any recovery.

[21]By contrast, under Section 11(b), other named defendants such as directors, officers, and underwriters, can avoid liability with "whistle-blowing" and "due diligence" defenses. Our formal analysis focuses on firm liability and abstracts away from lawsuits brought against other parties such as accountants, lawyers, and underwriters. Although a formal analysis is beyond the scope of this paper, we envision allowing for "gatekeeper" liability to expand the analysis in a few dimensions. First, having a gatekeeper to conduct due diligence can allow for better discovery of information (reduce π). At the same time, however, the presence of another agent can create a possibility of collusion between the agent and the firm. Overall, how such agents are being incentivized (formally and informally) can play an important role in both information discovery, deterrence, and collusion.

[22]Section 11(e) of the Act also allows damages if investors sold the stock after the suit was brought (but before judgment), but only if the damages are less than damages computed based on the time suit was brought.

[23]See Coffee (2006) at 1545–1547. Defense costs account for 25% to 35% of the damages paid. Taken together, the average attorney compensation is over 57% to 67% of the damages paid. See also Scott and Silverman (2013) at 1189.

of their shares and their disclosure strategies.[24]

In light of the aforementioned concerns, there has been subsequent legislation and proposals to reform and streamline the system. For example, the express goal of the Private Securities Litigation Reform Act (PSLRA) in 1995 was to prevent frivolous lawsuits and reduce the costs of litigation. In one proposal, which has gained momentum, a company going public could include a federal forum provision in their charter or bylaws, so that Section 11 claims must be brought in a federal (rather a state) court.[25] In another proposal, the company would be allowed to opt out of the securities litigation system altogether.[26] The company could in effect design its own liability system by (for example) including a mandatory individual arbitration provision in its organizational document, such as the charter, bylaws, or partnership/membership agreement.[27]

Allowing companies to opt out of the securities litigation system and to design their own liability rules and dispute resolution procedures raises a host of complex issues. How would private liability systems affect the workings of the IPO market and private companies' incentives to raise financing through an IPO? Will private liability systems adequately compensate the harmed investors versus lining the pockets of attorneys? Would a sophisticated investor be willing to purchase a security that is backed by private (rather than public) liability? Will private liability do a better job or a worse job at deterring material misstatements and omissions? And how would a privately-designed liability system differ from a publicly-designed system? The objective of this article is to shed some light on these complex questions with the help of economic theory.

4 The Model

Suppose that an entrepreneur E owns a firm that needs capital of $c > 0$. When E raises c and incurs a personal cost of $e > 0$, $c + e$ is invested and the cash-flow

[24] See Bohn and Choi (1996), Lowry and Shu (2002), and Hanley and Hoberg (2012).

[25] See Aggarwal, Choi, and Eldar (2020).

[26] See Scott and Silverman (2013).

[27] In 2012, when private equity firm the Carlyle Group, L.P. was going public, they included an arbitration provision in their partnership agreement. After meeting strong resistance from the lawmakers (including US senators) and the SEC, the provision was removed. See Lipton (2012). More recently, Johnson & Johnson shareholders demanded that the company allow its shareholders to vote on a mandatory arbitration proposal. See *Doris Behr 2012 Irrevocable Trust v. Johnson & Johnson*, 2022 US Dist. LEXIS 46891 (DNJ 2022).

stream of $x > 0$ is realized, where $x \in \{x_h, x_l\}$ and $prob(x = x_l) = q \in (0, 1)$.[28] Let $k \equiv c + e$, where k stands for the total investment necessary for the project, and $\overline{x} \equiv q \cdot x_l + (1 - q) \cdot x_h$. We assume that $x_l < k < \overline{x} < x_h$.

E raises capital from a competitive capital market by having the firm sell fraction $\alpha \in [0, 1]$ of the firm's equity to outside investors, whose reservation value is normalized to zero. For instance, with complete information and when $x = x_h$, the outside investors would pay c for a fraction $\alpha = c/x_h$ of the equity of the firm. The outside investors break even in this complete information scenario, since $\alpha \cdot x_h - c = (c/x_h) \cdot x_h - c = 0$.

There are six periods in the game with no discounting, $t \in \{0, 1, 2, 3, 4, 5\}$, and the timing of the game is as follows.

At $t = 0$, Nature chooses $x = x_l$ with probability q and $x = x_h$ with probability $1-q$. E learns the realized x with probability $\pi \in (0, 1)$. E who learns x is "informed" while E who does not learn x is "uninformed." Among the informed E, we denote E (and the firm) who knows that $x = x_h$ as the "h-type" and that $x = x_l$, the "l-type." We denote the uninformed E as the "u-type." Hence, there are three possible types of E (or the firm): h-type, l-type, and u-type.[29]

Consistent with Grossman (1981), Milgrom (1981), and Shavell (1994), we assume that if E is informed then E has hard evidence about x. The h-type can "prove" to the market that they are the h-type by disclosing the hard evidence. The l-type and the u-type cannot masquerade as the h-type, as they do not have any hard evidence to back this up. However, there is no way for the u-type to prove to the market that they *did not* learn x. As a consequence, the l-type can masquerade as the u-type by withholding the hard evidence that $x = x_l$. When the l-type withholds evidence, the l-type is in effect lying and falsely claiming that they are the u-type. In that sense, our model captures affirmative misstatements as well as non-disclosure of material information.[30]

[28] We can think of e as the amount of personal financial capital E has to pledge to get financing. We assume that c and e are both contractible, so the entrepreneur cannot abscond with the capital.

[29] We assume that q and π are fixed and focus on the adverse selection problem. More generally, E might exert innovation effort to increase q or exert more effort to uncover the true cash flow (reduce π). Liability may can also affect long-run innovation and information acquisition incentives. For instance, given that being able to sell equity as the h-type is generally more profitable for E, liability regime can enhance the incentive to increase q. At the same time, conditional on q, the liability system can increase or decrease the incentive for E to acquire information.

[30] If we drop the assumption that the h-type is endowed with "hard" evidence, the model can be extended to allow for E to present "false" evidence and engage in affirmative misstatement, where, for instance, either the l-type or the u-type pretends to be the h-type by presenting false evidence

At $t = 1$, E decides whether to participate and raise capital. If E chooses not to participate, then the game ends and both the investors and E get a return of zero. If E chooses to participate, then the game continues.[31]

At $t = 2$, the informed E chooses whether to disclose x or not disclose ("withhold") x. The outside investors observe the entrepreneur's disclosure decision and the disclosed information, if any, and update their belief about x.

At $t = 3$, the firm attempts to raise capital c by issuing equity stake α to outside investors.[32] Outside investors are rational and forward looking and the capital market is competitive. The equity stake α allows investors to break even given their (endogenous) beliefs about the value of the firm x and their returns from future litigation. If the firm fails to raise capital, then the game ends.

At $t = 4$, investments c and e are sunk and returns are realized.[33] Investors (now, shareholders of the firm) see the true value $x \in \{x_h, x_l\}$ and, if $x = x_l$, also receive an imperfect signal $\sigma \in \{0, 1\}$ indicating whether E withheld information at $t = 2$.[34] If E is the l-type, then $\sigma = 1$ for sure (there are no false negatives), and if E is the

to the investors. Although a complete analysis is beyond the scope of this paper, with affirmative misstatement, while the main thesis will remain qualitatively the same, there will be at least a few complications. First, given that the l-type can gain more from pretending to be the h-type (through affirmative misstatement) than pretending to be the u-type (through non-disclosure), achieving full deterrence will require larger damages: $\overline{d}$ will be larger. Also, when both the l-type and the u-type can engage in affirmative misstatement, without full deterrence, the equilibrium can involve one or both types engaging in affirmative misstatement (with positive probability). This will also make the determination of the equilibrium market price, at both the equity sale and after the revelation of cash flow, more involved.

[31] E's choice to participate is a firm commitment and she cannot change her mind later. This assumption simplifies the equilibrium characterization.

[32] We focus on equity rather than debt financing. In practice, most of the legal issues arise from stock sales, perhaps because debt tends to be (much) less "information sensitive" than equity. Our framework can be extended to include debt financing. For instance, suppose cash flows are noisy and x_h and x_l are the expected values. If some cash flows realizations are insufficient to satisfy the debt obligation, the risky debt will resemble equity and our results go through.

[33] The assumption that both e and c are being sunk at $t = 4$ is made largely for convenience. We can alternatively assume that the entrepreneur spends e earlier, e.g., at $t = 1$, and the firm spends c at $t = 4$. The main analysis will stay the same.

[34] As discussed in Section 3, for an investor to prevail on a Section 11 claim in an IPO setting, the investor must show that (1) there was a material omission (or misstatement) and (2) the investor was harmed. The realization $x = x_l$ is sufficient to demonstrate harm but not material omission. Signal σ provides the necessary (and potentially false) evidence of material omission. Our model allows for non-meritorious (or even "frivolous") lawsuits.

u-type, then $\sigma = 1$ with probability $\lambda \in [0, 1]$ (there may be false positives).[35] If $\sigma = 0$ the game ends and if $\sigma = 1$ investors can bring suit against the firm.[36]

At $t = 5$, there is a trial and the court awards damages $d \in [0, x_l]$.[37] Litigation is costly; the plaintiff-shareholders bear litigation cost $\gamma \cdot d$ where $\gamma \in [0, 1)$.[38] γd is the cost of legal representation for the plaintiff-shareholders: the larger the potential recovery, more lawyer hours are spent in litigation. We let $\gamma_0 \leq \gamma$ represent the lawyer's outside reservation value (opportunity cost). If $\gamma_0 < \gamma$ then the lawyer captures $(\gamma - \gamma_0)d$ as rent.[39]

For simplicity, we assume throughout the analysis that the investors who purchase the stock at the time of the equity offering (at $t = 3$) will retain ownership of the stock through the litigation. Given the fluid stock market, however, this assumption may be too strong. We can allow the investors to sell the stock either before or after they realize that they may have a claim against the firm (for instance, before or after $t = 4$). Under the existing law, because an investor who purchases the stock at an elevated price before the non-disclosure (or misstatement) is uncovered can bring a claim against the firm, even if we were to allow the investors to trade the stock before the lawsuit, the analysis will go through.[40]

Our social welfare concept is the aggregate value captured by the entrepreneur, the investors, and the lawyers. The equilibrium concept is perfect Bayesian Nash equilibrium (PBNE).

[35] We assume that the error rate λ is exogenous. In our model, the court is not a Bayesian player of the game. If the firm value is low and the signal indicates that E withheld information, the court rules in favor of the investors. Hence, even with full deterrence, the u-type can be found liable. If we were to allow for a Bayesian court, while the analysis will become more complicated, the qualitative results will not change. The full deterrence equilibrium will likely disappear, however. We can also allow for false negatives (where the court exonerates the non-disclosing l-type). Allowing for false negatives would complicate the analysis but would not change the qualitative results.

[36] The investors sue the firm rather than the entrepreneur. This is common in practice, as entrepreneurs may not have sufficient assets to pay monetary damages. The case of holding the entrepreneur directly liable for non-disclosure is considered in the Appendix B.

[37] The firm enjoys limited liability and cannot be held responsible for more than its cash-flow (x_l). For analytic simplicity, damages are fixed and don't depend on α. Alternatively, we could explore compensatory damages where investors recover $max\{0, min\{\theta(\alpha x_l - c), x_l\}\}$ where $\theta \in [0, \infty)$.

[38] Empirically, lawsuits with higher stakes have higher litigation costs on average (Choi et al., 2020). For simplicity, only the plaintiff-shareholders bear the cost of litigation. The model can be easily generalized to include litigation costs for the defendant-firm. See Appendix B for details.

[39] There is fairly robust empirical evidence that class action lawyers receive "windfall fee awards," particularly in large cases. See Helland and Klick (2007), Choi et al. (2020), and Choi et al. (2022). We are using the phrase "lawyer's rent" broadly. What is important for our results is that some returns from litigation are being captured by third parties (lawyers, experts, or cy pres claimants).

[40] More detailed analysis on stock sale is presented in Appendix B.

4.1 Preliminary Analysis

We begin by describing a benchmark with full information and no liability. Since $x_l < k < \overline{x} < x_h$, it is socially efficient for the entrepreneur to raise capital and pursue the venture *unless* the project is known to have low value (x_l). If a social planner possessed the same information as the entrepreneur, the social planner would fund the project if the value was known to be high ($x = x_h$) or if the project had unknown value, but not if $x = x_l$. This is the first-best outcome.

This first-best outcome would be obtained in a competitive market if the investors had the same information as the entrepreneur. To see why, suppose that the entrepreneur and capital market learn that $x = x_h$. The investors would pay c for equity stake $\alpha_h = c/x_h$, thus breaking even, and the entrepreneur would receive a positive return $x_h(1 - \alpha_h) - e = x_h - c - e > 0$. Similarly, if they do not learn x, then the investors would pay c for equity stake $\overline{\alpha} = c/\overline{x}$ and E's (expected) return would be $(1 - \overline{\alpha})\overline{x} - e = \overline{x} - c - e > 0$. Finally, if the entrepreneur and capital market learn that $x = x_l$ then no capital would be raised. To break even, investors would demand a large equity stake, $\alpha_l = c/x_l$, and E's return would be negative: $(1 - \alpha_l)x_l - e = x_l - c - e < 0$. With full information, the entrepreneur would raise capital and pursue the business venture *unless* the project is commonly known to be of low value.

This full-information benchmark may not be sustainable when the entrepreneur is privately informed. Suppose E privately learns that $x = x_l$ (they are the l-type). If E *pretends* to be the uninformed u-type, they would get a net return $(1 - \overline{\alpha})x_l - e$ where $\overline{\alpha} = c/\overline{x}$. When e is small, the l-type would have an incentive to withhold hard evidence that $x = x_l$ and raise capital.

Going forward, we maintain the following assumptions:

Assumption 1: $e < (1 - c/\overline{x})x_l$.

Assumption 1 implies that a moral hazard problem exists. If there is no liability (for non-disclosure), the l-type has an incentive to withhold their private information and pool with the u-type. With the assumption, we get: $(1 - \overline{\alpha})x_l - e > 0$.[41]

Assumption 2: $\overline{x} - k - q\lambda\gamma x_l > 0$.

[41] If court error rate λ is very high, the h-type may have a perverse incentive to withhold private information too. The following assumption guarantees the h-type prefers to disclose: $\frac{c}{x_h} < \frac{c - q(1-\gamma)\lambda x_l}{\overline{x} - q\lambda x_l}$. This holds when $\lambda = 0$, since $x/x_h < c/\overline{x}$, and more generally when λ is not too high.

Assumption 2 guarantees that the u-type's net return from participating in the market is positive even when courts are prone to error, litigation is costly, and damages are at their highest level, $d = x_l$.[42] This assumption will be satisfied if the error rate λ or the contingent fee percentage γ are not too high.

Assumption 3: $\gamma < e/x_l$.

Assumption 3 implies that, in equilibrium, the investors will have a credible threat to sue the firm for non-disclosure. Assumption 3 is satisfied if the share of the damage award captured by the lawyers is not too large.[43]

4.2 Equilibrium Characterization

We now construct a PBNE where the h-type participates and discloses x_h, the u-type participates and does not (indeed, cannot) disclose, and the l-type pools (or partially pools) with the u-type and does not disclose. In particular, we characterize values (α^*, β^*) where α^* is the equity stake demanded by investors (conditional on no disclosure) and β^* is the l-type's participation probability.[44]

We begin by investigating the l-type's decision to participate and raise capital. If the l-type participates, the outside investors (and their lawyers) observe signal $\sigma = 1$ and bring suit against the firm for damages d. After the payment of damages d, the residual firm value of $x_l - d \geq 0$ is divided between the outside investors and the entrepreneur in proportions α^* and $1 - \alpha^*$. The l-type participates and raises capital if their gross return, $(1 - \alpha^*)(x_l - d)$, exceeds the personal investment e. We have

[42] The expression $q\lambda\gamma x_l$ is the expected litigation cost when E is the u-type and $d = x_l$. $q\lambda$ is the probability that the investors will bring a lawsuit and γx_l is the contingent fee. Since investors break even on average, the litigation cost is effectively borne by the entrepreneur.

[43] This assumption would be unnecessary if the lawyers, rather than the investors, control the decision to bring suit. If the contingent fee exceeds the lawyers' opportunity cost of time ($\gamma > \gamma_0$) and the fixed cost is negligible, the lawyers would bring even lawsuits that have negative expected value for the investors. If, however, investors retain control over litigation and γ is sufficiently high, litigation has a negative expected value for the plaintiff-investors when the potential recovery (d) is small. Although a full analysis is beyond the scope of this paper, our conjecture is that this will impose a threshold $d^c(\pi)$, such that when $d < d^c(\pi)$, investors will decline to bring suit after x_l has been revealed. Also, when $d < d^c(\pi)$, given that the investors do not expect to get any recovery from strategic non-disclosure, the investors will demand a larger α ex ante to satisfy their break-even condition. Finally, when $d < d^c(\pi)$ and the l-type is only partially deterred, the l-type will participate with a higher probability. This will be apparent when we derive the equilibrium participation probability of $\beta^*(d, \pi)$.

[44] We will prove that this equilibrium exists for all $d \in [0, x_l]$.

the following characterization of β^*, the l-type's participation probability:

$$\begin{cases} \beta^* = 0 & \text{if} \quad (1-\alpha^*)(x_l - d) - e < 0 \\ \beta^* \in [0,1] & \text{if} \quad (1-\alpha^*)(x_l - d) - e = 0 \\ \beta^* = 1 & \text{if} \quad (1-\alpha^*)(x_l - d) - e > 0 \end{cases} \tag{1}$$

Depending on the level of damages d, the equilibrium may involve full deterrence of the l-type ($\beta^* = 0$), partial deterrence ($\beta^* \in (0,1)$), or no deterrence ($\beta^* = 1$).

Next, consider the equity stake α^* demanded by outside investors if there is no disclosure at $t = 2$. Since the l-type does not disclose and the u-type cannot disclose in the proposed equilibrium, E could be either an l-type or a u-type. The investors' break-even condition, conditional on non-disclosure, may be written as:[45]

$$(1-\pi)[\alpha^*\overline{x} - c + q\lambda(1-\gamma-\alpha^*)d] + \pi q\beta^*[\alpha^* x_l - c + (1-\gamma-\alpha^*)d] = 0. \tag{2}$$

The equation shows that the equilibrium equity stake α^* will depend on, among others, the equilibrium probability of participation by the l-type (β^*).

Equation (2) may be understood intuitively. Consider the second half of the expression. The term $\pi q\beta^*$ represents the joint probability that E is both the l-type (πq) and participates in raising capital (β^*), while the expression in square brackets is the investors' return associated with the l-type. Recall that when E is the l-type the firm pays d in damages. Since the the investors own share α^* of the firm, fraction α^* of the damage award is paid by the investors themselves. Hence, $(1-\gamma-\alpha^*)d$ is the investors' net damage award after accounting for the payment γd to the lawyers and the reduction $\alpha^* d$ in equity value. Similarly, in the first half of the equation, $1-\pi$ is the probability that E is the u-type, $q\lambda$ is the probability that the u-type is sued, and $(1-\gamma-\alpha^*)d$ is the investors' net damage award.

When the level of liability is above a certain threshold, $\overline{d}$, the l-type entrepreneur will be fully deterred, $\beta^* = 0$. It is not difficult to construct the threshold, and we provide a sketch of the argument here. The formal statement is in the following Lemma and the full proof is in the appendix.

First, setting $\beta^* = 0$ in equation (2) gives the equilibrium equity stake α^* that

[45] Conditional on non-disclosure, the probability that E is the u-type is $\frac{1-\pi}{1-\pi+\pi q\beta^*}$ and the probability that E is the l-type is $\frac{\pi q\beta^*}{1-\pi+\pi q\beta^*}$.

would be demanded by the investors when the l-type is fully deterred:

$$\alpha^* = \overline{\alpha}(d) = \frac{c - q(1-\gamma)\lambda d}{\overline{x} - q\lambda d}. \tag{3}$$

If the court error rate is zero, $\lambda = 0$, then investors demand $\overline{\alpha} = c/\overline{x}$, which is independent of d. More generally, holding $\lambda > 0$ fixed, the equity stake $\overline{\alpha}$ is a decreasing function of d. Because the investors' future net recovery from litigation against the u-types rises when d rises, investors demand a smaller fraction of the firm. The equity stake $\overline{\alpha}$ decreases in court error λ (as higher error corresponds to a higher future net recovery) while increasing in the litigation cost γ (as lawyers dilute the future value of the equity).

Next, at the full-deterrence threshold $\overline{d}$, the l-type must be just indifferent between participating and not. From equation (1), indifference requires that that $\overline{d} = x_l - e/(1-\alpha^*)$. This expression, together with (3), implicitly defines $\overline{d}$. We have the following result.

Lemma 1. *(Full Deterrence Threshold.) There exists a threshold $\overline{d} > 0$ such that the l-type is fully deterred, $\beta^*(d, \pi) = 0$, when $d > \overline{d}$. Investors demand equity stake $\overline{\alpha}(d)$ defined in (3) where $\frac{\partial \overline{\alpha}}{\partial d} < 0$, $\frac{\partial \overline{\alpha}}{\partial \lambda} < 0$ and $\frac{\partial \overline{\alpha}}{\partial \gamma} > 0$. Threshold $\overline{d}$ is implicitly defined by:*

$$\overline{d} = x_l - \frac{e}{1 - \overline{\alpha}(\overline{d})} > 0, \tag{4}$$

where $\frac{\partial \overline{d}}{\partial \pi} = 0$, $\frac{\partial \overline{d}}{\partial e} < 0$, $\frac{\partial \overline{d}}{\partial \lambda} > 0$ and $\frac{\partial \overline{d}}{\partial \gamma} < 0$.

The full-deterrence threshold $\overline{d}$ in Lemma 1 has several notable properties. First, $\overline{d}$ is independent of π. With the complete deterrence of the l-type, the outside investors need not worry about the "degree" of adverse selection, represented by π. Second, $\overline{d}$ is a strictly decreasing function of e. Deterrence is easier to achieve when the entrepreneur has more at stake in the venture. Third, as e approaches 0, $\overline{d}$ approaches x_l. When the entrepreneur personally invests very little in the venture, full-deterrence requires damages that effectively liquidate the firm's assets with nothing remaining for the entrepreneur.

Fourth, the threshold $\overline{d}$ defined in (4) is less than fully compensatory. The level of damages that would would allow the investors to break even, call it d^0, would need to satisfy $\overline{\alpha}x_l - c + (1-\gamma-\overline{\alpha})d^0 = 0$. Notice that the investors do not actually get the whole damage award, d^0, as fraction γ is captured by the lawyers and fraction $\overline{\alpha}$ is paid by the investors themselves. Rearranging, $d^0 = (c - \overline{\alpha}x_l)/(1-\gamma-\overline{\alpha})$. By contrast, the threshold $\overline{d}$ defined in (4) may be written as $\overline{d} = [(1-\overline{\alpha})x_l - e]/(1-\overline{\alpha})$.

Comparing d^0 to $\overline{d}$ confirms that $d^0 > \overline{d}$ for all $\gamma \geq 0$. The reason is straightforward. Making the investors whole would make the l-type into the full residual claimant of a negative expected value project. Since $x_l - c - e < 0$, fully compensatory damages are higher than necessary to achieve full deterrence.[46]

According to Lemma 1, changes in the rate of false positives λ and the litigation cost γ have opposite effects on $\overline{d}$. This is fairly intuitive. As the rate of false positives grows (λ increases), the investors recover more from the u-type. This leads to a lower equilibrium α which, in turn, makes it more attractive for the l-type to participate in financing. To restore full deterrence, $\overline{d}$ has to increase. On the other hand, when the cost of litigation rises (γ increases), this lowers the investors' net recovery from litigation, thereby leading them to demand a higher α to satisfy their break-even condition. With a larger fraction of the firm sold to the investors, it becomes less attractive for the l-type to participate in financing, thereby lowering $\overline{d}$.[47]

If the damages for non-disclosure are below the threshold in Lemma 1 then full deterrence is not possible. The l-type is either not deterred or only partially deterred, depending on the damages $d < \overline{d}$ and the degree of adverse selection, π. Consider the extreme case where π is close to 0. Since almost all entrepreneurs are u-types, investors would not draw adverse inferences from non-disclosure. The l-type's net return from participation would be positive and they would participate for sure, $\beta^* = 1$. Now, consider the other extreme case where π is close to 1. Since there are very few u-types, investors would naturally draw adverse inferences from non-disclosure. If the l-type participated for sure, investors would demand a very high equity stake to compensate them for this risk. Indeed, if π is close to 1 and the l-type participated for sure, the premium demanded by investors would be so high as to render the l-type's net return negative. In equilibrium, when $d < \overline{d}$ and π is close to 1, the l-type participates with a very small probability.[48]

At the opposite end of the spectrum, we can also see that when d is sufficiently small ($d < \underline{d}(\pi)$), the l-type may be completely undeterred ($\beta^* = 1$). A formal

[46]One interesting aspect about $\overline{d}$ and d^0 is that, d^0 is decreasing in x_l but $\overline{d}$ is increasing in x_l. That is, while the compensatory damages are decreasing with respect to the project value, the full deterrence threshold is increasing with respect to the project value. This comes from the fact that, all else equal, to make investors whole, one would need the damages to be higher when cash flows are lower. For deterrence, the low value of x_l by itself is serving as a deterrent partially because the entrepreneur gets $(1 - \alpha)$ fraction of the cash flow. In a sense, we can think of this as the market incentives being more aligned, even without liability, when x_l is low.

[47]Lemma 1 implies that full deterrence may require supra-compensatory damages in the sense that the investors collect more in damages than the overcharge for the assets. To see why, not that if e is very small, then $\overline{d}$ is close to x_l. This could be much larger than the overcharge $c - \alpha x_l$.

[48]The equilibrium equity stake α^* makes the l-type indifferent between participating and not.

statement is in the following Lemma and a detailed proof is in the appendix, but here is a rough sketch of the construction of this lower threshold. Setting $\beta^* = 1$ in the investors' break-even condition (2) and rearranging gives

$$(1-\pi)[\alpha^*(\overline{x} - q\lambda \underline{d}) - c + q(1-\gamma)\lambda \underline{d}] + \pi q[\alpha^*(x_l - \underline{d}) - c + (1-\gamma)\underline{d}] = 0. \tag{5}$$

At the threshold $\underline{d}$ the l-type is just indifferent between participating and not participating so, from equation (1), we have $(1-\alpha^*)(x_l - \underline{d}) - e = 0$. This expression, together with equation (5), define the lower threshold $\underline{d}$ and the associated equity stake α^*. As shown in the appendix, when $d = \underline{d}$, the equilibrium equity stake is

$$\alpha^*(\underline{d}, \pi) = \overline{\alpha}(\underline{d}) + r(\underline{d}, \pi) \tag{6}$$

where the function $\overline{\alpha}(d)$ was defined earlier in (3) and the function $r(\underline{d}, \pi)$ satisfies

$$r(\underline{d}, \pi) = \frac{\pi q}{1-\pi} \cdot \frac{k + \gamma \underline{d} - x_l}{\overline{x} - q\lambda \underline{d}}. \tag{7}$$

The function $r(\underline{d}, \pi)$ defined in (7) is the incremental equity stake demanded by the outside investors when the l-type is (just) deterred. Intuitively, if the l-type is undeterred, the outside investors will demand a "premium" to compensate for the risk that E is the l-type. If $\pi = 0$, so there are no l-types, then the premium in (7) is zero. The premium is an increasing function of π; the investors will demand a higher fraction of the firm as the degree of adverse selection increases.

Lemma 2. *(No Deterrence Threshold.) There exist thresholds $\underline{d}(\pi) \in [0, \overline{d}]$ and $\widehat{\pi}_0 \in (0,1)$ such that the l-type is undeterred, $\beta^*(d,\pi) = 1$, if $d < \underline{d}(\pi)$. If $\pi > \widehat{\pi}_0$, then $\underline{d}(\pi) = 0$. If $\pi \leq \widehat{\pi}_0$, then $\underline{d}(\pi)$ is implicitly defined by:*

$$\underline{d} = x_l - \frac{e}{1 - \overline{\alpha}(\underline{d}) - r(\underline{d}, \pi)} \tag{8}$$

where $\overline{\alpha}(\underline{d})$ and $r(\underline{d}, \pi)$ are defined in (3)and (7). $\frac{\partial \underline{d}}{\partial \pi} < 0$ with $\underline{d}(0) = \overline{d}$ and $\underline{d}(\widehat{\pi}_0) = 0$.

The no-deterrence threshold characterized in Lemma 2 has several notable properties. When $\pi = 0$, so there are no l-types and no adverse selection, the premium demanded by investors $r(\underline{d}, \pi) = 0$ and $\underline{d}(0) = \overline{d} > 0$ defined in equation (4). When π rises then $\underline{d}(\pi)$ falls, so deterrence is easier to achieve. As π rises and the outside investors demand a larger equity stake compensate them for the increased risk, the entrepreneur's cost of capital becomes higher, too. The higher cost of capital discourages the l-types from participating in the market. According to Lemma 2, when π is above a threshold $\widehat{\pi}_0 \in (0,1)$, the l-type will be partially deterred ($\beta^* < 1$) even when there is no liability ($d = 0$).

The thresholds $\overline{d}$ and $\underline{d}(\pi)$ characterized in Lemmas 1 and 2 allow us to describe the PBNE of the game.

Proposition 1. *(Equilibrium Characterization.) Consider liability thresholds $\overline{d}$ and $\underline{d}(\pi)$ defined in Lemma 1 and Lemma 2, respectively.*

1. *Full Deterrence. If $d > \overline{d}$, then investors demand equity stake $\alpha^*(d,\pi) = \overline{\alpha}(d)$, defined in (3). $\alpha^*(d,\pi)$ is decreasing in d and does not depend on π. The l-type is fully deterred, $\beta^*(d,\pi) = 0$.*

2. *Partial Deterrence. If $\underline{d}(\pi) \leq d \leq \overline{d}$, then investors demand equity stake*

$$\alpha^*(d,\pi) = 1 - \frac{e}{x_l - d}. \tag{9}$$

$\alpha^*(d,\pi)$ is decreasing in d and does not depend on π. The l-type is partially deterred,

$$\beta^*(d,\pi) = \frac{1-\pi}{\pi q} \cdot \frac{(1 - \frac{e}{x_l - d})(\overline{x} - q\lambda d) - (c - q(1-\gamma)\lambda d)}{k + \gamma d - x_l}, \tag{10}$$

where $\beta^*(d,\pi) \in [0,1]$ is decreasing in d and π with $\lim_{d \to \overline{d}} \beta^*(d,\pi) = 0$ and, if $\pi \leq \widehat{\pi}_0$, $\lim_{d \to \underline{d}(\pi)} \beta^*(d,\pi) = 1$.

3. *No Deterrence. If $d < \underline{d}(\pi)$, then investors demand equity stake*

$$\alpha^*(d,\pi) = \frac{(1-\pi)(c - q(1-\gamma)\lambda d) + \pi q(c - (1-\gamma)d)}{(1-\pi)(\overline{x} - q\lambda d) + \pi q(x_l - d)}. \tag{11}$$

$\alpha^*(d,\pi)$ is decreasing in d. The l-type is undeterred, $\beta^*(d,\pi) = 1$.

The equilibrium described in Proposition 1 divided into three regions: a region where the l-type is fully deterred ($\beta^* = 0$); where the l-type is not deterred ($\beta^* = 1$); and where l-type is only partially deterred and randomizes between participating and not ($\beta^* \in (0,1)$). The equilibrium is illustrated in Figure 1.

The full-deterrence and no-deterrence regions were discussed in the earlier Lemmas. Consider the second case of partial deterrence where $\underline{d}(\pi) \leq d \leq \overline{d}$. The equilibrium l-type participation rate $\beta^*(d,\pi)$, characterized (10), has some notable and intuitive properties. First, the l-type participation rate β^* is smaller when the damage award d is larger. In other words, the l-type is deterred by legal liability. When the liability system is stronger, it becomes more costly for the l-type to not

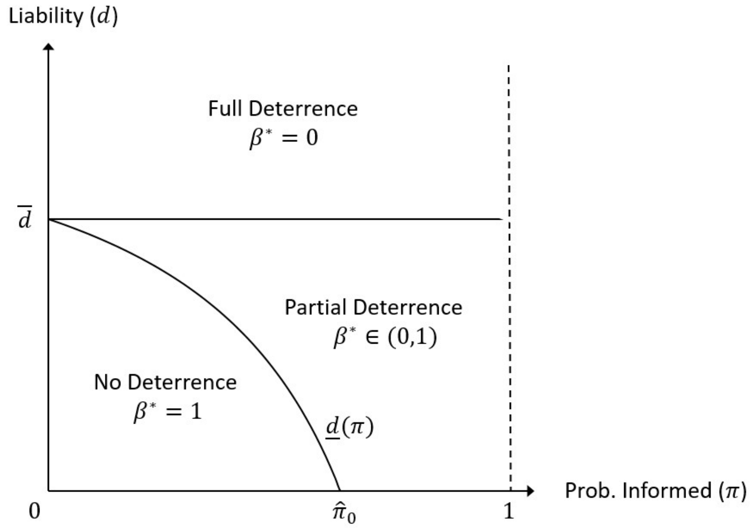

Figure 1: Equilibrium Characterization

disclose the information, and therefore easier to partially deter the l-type from participating in the market. Second, the l-type's participation rate β^* is decreasing in π, the fraction of informed entrepreneurs. When π is larger, the adverse selection problem is worse. To maintain investor indifference, fewer l-types participate. In the limit, when $\pi \to 1$, $\beta^* \to 0$: when the entrepreneur is perfectly informed, the full unraveling result (Grossman (1981) and Milgrom (1981)) obtains.[49]

It is also worth emphasizing the importance of our assumption that the l-type's investment is socially wasteful: $x_l - c - e < 0$. According to Proposition 1, liability for non-disclosure deters the l-type entrepreneur from participating in the capital market and this leads to a more efficient allocation of capital. If, instead, the l-type investment was socially beneficial, $x_l - c - e > 0$, it is easy to show that the l-type will always participate and raise capital *regardless of the liability rule.*[50] In that setting, when d is sufficiently large, the l-type will simply disclose the bad news, $x = x_l$, and sell equity stake of $\alpha_l = c/x_l$ to the outside investors. Thus, if the

[49]For comparison, we know from Lemma 2 that when $\pi \to 0$ then $\underline{d}(\pi) \to \overline{d}$ so $\beta^* = 1 \; \forall d < \overline{d}$, and welfare loss again goes to zero.

[50]Consider a PBNE with full-disclosure by the l-type. If the l-type discloses, $\alpha_l = c/x_l$ and the l-type's payoff is $(1-\alpha_l)x_l - e = x_l - c - e > 0$. If the l-type were to mimic the u-type and withhold information, investors demand $\overline{\alpha} = c/\overline{x}$ and the l-type's payoff becomes $(1-c/\overline{x})(x_l - d) - e$. Setting these expressions equal gives the threshold $d = c(\overline{x} - x_l)/(\overline{x} - c) > 0$. When d is above the threshold then the equilibrium involves full disclosure by the l-type; when d is below the threshold the equilibrium involves no disclosure by the l-type. In both cases the l-type project is pursued, which is socially efficient.

l-type investment was socially worthwhile, holding the firm liable for non-disclosure of material information would have no effect on the allocation of capital or on social welfare.

4.3 The Socially-Optimal Liability Rule

It is straightforward to evaluate the effect of firm liability on social welfare. In the PBNE in Proposition 1, the h-type and the u-type participate with certainty and the l-type participates with probability $\beta^*(d,\pi)$. From an ex ante perspective, the expected social welfare is:

$$SW(d,\pi) = (1-\pi)(\overline{x}-k-q\lambda\gamma_0 d)+\pi(1-q)(x_h-k)+\pi q\beta^*(d,\pi)(x_l-k-\gamma_0 d). \quad (12)$$

The second term in equation (12) is the expected social value from the participating h-types. The third term is the social loss associated with the l-types. Notice that $\gamma_0 \cdot d$ are the real costs from using the legal system (the opportunity cost of the lawyer's time).[51] The first term in equation (12) is the social value associated with the u-types. This first term also includes litigation costs as some u-types are erroneously sued for non-disclosure. The social welfare function in (12), together with the characterization of $\beta^*(d,\pi)$ in Proposition 1, delivers the following comparative statics.

Lemma 3. *(Social Welfare Comparative Statics.)*

1. *Full Deterrence. If $d > \overline{d}$, then $\beta^*(d,\pi) = 0$. Social welfare is decreasing in d.*

2. *Partial Deterrence. If $\underline{d}(\pi) \leq d \leq \overline{d}$, then $\beta^*(d,\pi) \in [0,1]$. Social welfare is increasing in d.*

3. *No Deterrence. If $d < \underline{d}(\pi)$, then $\beta^*(d,\pi) = 1$. Social welfare is decreasing in d.*

With the results from Lemma 3, we can now characterize the socially-optimal liability rule. When d rises, social welfare is falling in the no-deterrence region ($d > \overline{d}$), rising in the partial deterrence region ($\underline{d}(\pi) \leq d \leq \overline{d}$), and falling in the full deterrence region ($d < \underline{d}(\pi)$). The result straightforwardly implies that the socially-optimal damage award is $d_s^* \in \{0, \overline{d}\}$. Furthermore, the social planner prefers $d = 0$ to $d = \overline{d}$ if and only if $SW(0,\pi) \geq SW(\overline{d},\pi)$. This leads to two cases that we need to consider.

According to Lemma 2, if the proportion of informed entrepreneurs is above a threshold, $\pi \geq \widehat{\pi}_0$, then $\underline{d}(\pi) = 0$. This in turn implies that $d \geq \underline{d}(\pi)\ \forall d \geq 0$. Hence,

[51] We are assuming here that the rent captured by the lawyers, $(\gamma - \gamma_0)d$, does not impose any deadweight loss and, therefore, does not create any welfare loss. This will play an important role when we examine the divergence between private and social incentive to waive liability.

we are in cases 1 or 2 of Lemma 3 and social welfare is maximized by $d = \overline{d}$. Suppose, on the other hand, $\pi < \widehat{\pi}_0$, and the proportion of informed entrepreneur is relatively small. Lemma 2 implies that $\underline{d}(\pi) > 0$. If $d = 0$, then we are in the no-deterrence region and $\beta^*(d, \pi) = 1$. Using (12), one can show that the social planner prefers no liability $d = 0$ to full deterrence with $d = \overline{d}$ if and only if:[52]

$$(1-\pi)q\lambda\gamma_0\overline{d} > \pi q(k - x_l). \tag{13}$$

This expression is intuitive. The left-hand side is the efficiency loss (from the ex ante perspective) when $d = \overline{d}$ and there is full deterrence. Although the l-type is fully deterred, there is a loss of legal resources of $\gamma_0\overline{d}$ when investors bring non-meritorious lawsuits against the u-type, which happens with probability $(1-\pi)q\lambda$.[53] The right-hand side is the expected efficiency loss when there is no liability ($d = 0$) as the l-type participates with probability one. We have the following result.

Proposition 2. *(Socially-Optimal Liability Rule.) Social welfare is maximized with liability rule $d = d_s^* \in \{0, \overline{d}\}$ where $\overline{d}$ is defined in (4). Let threshold $\widehat{\pi}_s \in (0, \widehat{\pi}_0)$ satisfy*

$$\frac{1-\widehat{\pi}_s}{\widehat{\pi}_s q} = \frac{k - x_l}{q\gamma_0\lambda\overline{d}}. \tag{14}$$

If $\pi < \widehat{\pi}_s$, the socially-optimal liability rule is $d_s^* = 0$. If $\pi \geq \widehat{\pi}_s$, the socially-optimal liability rule is $d_s^* = \overline{d}$.

The proposition tells us that the socially-optimal liability rule is either the minimal damages required for full deterrence, $d_s^* = \overline{d}$, or no liability at all, $d_s^* = 0$. If the proportion of informed types π is below a threshold $\widehat{\pi}_s$, then no liability is the socially-optimal rule. This makes intuitive sense. Suppose $\pi \to 0$ and nearly every entrepreneur is uninformed. In the limit, the welfare loss from l-type's participation becomes vanishingly small, so the social benefit of liability is negligible. The social cost of liability is significant, however, since court error implies lawsuits will be brought against the u-type. Lawsuits against the u-type involve wasted economic resources, i.e., the opportunity cost of the lawyers' time and effort. Thus, when π (the proportion of informed entrepreneurs) is small, no liability is optimal: $d_s^* = 0$. When π is large, on the other hand, the optimal damage award is exactly $d_s^* = \overline{d}$ for the opposite reasons.[54]

[52] See the proof of Proposition 2 in the appendix for details.

[53] Though settlement is not explicitly modeled, if the parties are able to settle out of court, this can avoid having to spend resources in litigation. This will, in turn, make the social planner more likely to favor full deterrence ($d = \overline{d}$) over no deterrence ($d = 0$).

[54] If the damages award were to exceed this threshold, the social cost of litigation $\gamma_0 \cdot d$ would be unnecessarily excessive and raising d will only reduce welfare.

Note also that the equilibrium threshold $\widehat{\pi}_s$ defined in (14) is (1) positively related to the lawyers' opportunity cost (γ_0) and the probability of legal error (λ) but (2) negatively related to the deadweight loss from the l-type's participation ($k - x_l$). Holding $k - x_l$ fixed, if either γ_0 or λ approaches zero, the social cost of lawsuits brought against the innocent u-type (measured by $\gamma_0\lambda\overline{d}$) gets very small and the socially-optimal liability rule becomes $d_s^* = \overline{d}$.[55] What matters for socially-optimal policy is how much resources (lawyers' opportunity cost) are being "wasted" by the non-meritorious lawsuits that are brought against the u-type. As the amount of resources spent against the u-type gets smaller, it becomes socially more desirable to provide full deterrence against the l-type. Similarly, as the deadweight loss from the l-type's participation gets larger ($k - x_l$ gets bigger), preventing the l-type from participating becomes more important and $\widehat{\pi}_s$ becomes smaller.

5 The Private Choice of Liability Rule

The last section characterized the socially-optimal liability rule, and showed that it would either involve no liability $d = 0$ or the minimal level necessary to fully deter the l-types, $d = \overline{d}$. We now explore the private design of liability rules, and why it might diverge from what is socially desirable.

For concreteness, we extend the game in the following way. Suppose that at time $t = 1$, if the entrepreneur decides to participate in the capital market then the entrepreneur can privately choose the level of damages, d. Like a warranty, liability provides a way for the u-type to signal to the capital market that they they have a worthwhile project and are not withholding bad news. The signal is costly for the u-type, as there will be false positives and litigation costs, but there are advantages too. If the u-type can convince the market that the risk of l-types is reduced, the u-type will be able to raise capital at better terms.

There cannot exist a separating equilibrium where the l-type and u-type choose different liability rules. Since the l-type has a socially-wasteful project, the l-type cannot profitably raise capital once their type is known to the market. There may however exist a pooling equilibrium where the l-type mimics the u-type in their choice of liability rule. Unless there is full deterrence ($\beta^* = 0$), whichever liability regime is chosen by the u-type, the l-type will follow. In the analysis that follows, we construct the pooling equilibrium that maximizes the returns of the u-type entrepreneur.

We begin by exploring the entrepreneur's preferences over liability rules. The

[55] From Lemma 1, $\overline{d}$ is an increasing function of λ and does not depend on γ_0.

next lemma, which follows from the equilibrium characterization in Proposition 1, describes how the u-type and l-type's net returns depend on the liability rule.

Lemma 4. *(Private Welfare Comparative Statics.)*

1. *Full Deterrence. If $d > \overline{d}$, then $\beta^*(d, \pi) = 0$. The u-type's expected return is decreasing in d and the l-type's return is independent of d.*

2. *Partial Deterrence. If $\underline{d}(\pi) \leq d \leq \overline{d}$, then $\beta^*(d, \pi) \in [0, 1)$. The u-type's expected return is increasing in d and the l-type's return is independent of d.*

3. *No Deterrence. If $d < \underline{d}(\pi)$, then $\beta^*(d, \pi) = 1$. The u-type's expected return may be increasing or decreasing in d and is a convex function of d, and the l-type's return is decreasing in d. As $\lambda \to 0$, the u-type's return is strictly increasing with respect to d.*

Lemma 4 delivers several insights. Most obviously, l-type (weakly) prefers lower level of liability, as it may free-ride on the u-type, participate in the market, and earn rents. The l-type's return is maximized with liability rule $d_l^* = 0$. Lemma 4 also implies that the u-type's privately-optimal liability rule is either no liability ($d = 0$) or liability just high enough to deter the l-types ($d = \overline{d}$). In Case 1 of Lemma 4, the u-type's return is decreasing d, and is therefore maximized at $\overline{d}$. In Case 2, the u-type's return is dincreasing d, and is therefore maximized at $\overline{d}$ as well. In Case 3 of Lemma 4, since the u-type's return is a convex function of d, an interior maximum does not exist. The u-types return is maximized at a corner solution, $d = 0$ or $d = \underline{d}(\pi)$. Taken together, the u-type's privately-optimal liability rule is either $d_u^* = 0$ or $d_u^* = \overline{d}$.

5.1 Private Liability Rule

We now characterize the equilibrium liability rule that will be chosen by the u-type (and participating l-type in the pooling equilibrium). Suppose that $\pi < \widehat{\pi}_0$ in Proposition 1 (i.e., the proportion of informed entrepreneur is below a threshold of $\widehat{\pi}_0$), so the l-type would be completely undeterred when $d = 0$. As shown in the appendix, the u-type prefers no liability $d = 0$ and no deterrence to $d = \overline{d}$ and full deterrence if and only if

$$(1 - \pi)q\gamma\lambda\overline{d} > \pi q[(k - x_l) + (1 - \alpha^*(0, \pi))x_l - e] \tag{15}$$

where, using (11),

$$\alpha^*(0, \pi) = \frac{(1 - \pi)c + \pi q c}{(1 - \pi)\overline{x} + \pi q x_l}. \tag{16}$$

The left-hand side of (15) is the u-type's expected loss (from the ex ante perspective) when $d = \overline{d}$. If $d = \overline{d}$, the l-type is fully deterred but the u-type must bear (indirectly) the payments to the lawyers. The expression, $(1-\pi)q\lambda$, represents the (ex ante) probability that the u-type gets sued under full deterrence. The right-hand side is the u-type's loss if there is no liability, $d=0$. This includes the social loss from the participation of the l-type $(k-x_l)$ plus the information rents that accrue to the l-type $((1-\alpha^*(0,\pi))x_l-e)$. These losses are multiplied by the ex ante probability of the l-type, πq. Substituting (16) into (15), and rearranging gives the following result.

Proposition 3. *(Private Liability Rule.) In the pooling equilibrium, the u-type and l-type entrepreneur choose liability rule $d=d_u^*\in\{0,\overline{d}\}$. Let $\widehat{\pi}_u\in(0,\widehat{\pi}_0)$ satisfy*

$$\frac{1-\widehat{\pi}_u}{\widehat{\pi}_u q}=\frac{(1-x_l/\overline{x})c-q\gamma\lambda\overline{d}x_l/\overline{x}}{q\gamma\lambda\overline{d}}. \tag{17}$$

If $\pi<\widehat{\pi}_u$, the liability rule is $d_u^*=0$. If $\pi\geq\widehat{\pi}_u$, the liability rule is $d_u^*=\overline{d}$.

The liability rule chosen in equilibrium is either the minimal damages required for full deterrence, $d_s^*=\overline{d}$, or no liability at all, $d_s^*=0$. If the proportion of informed type π is below a threshold $\widehat{\pi}_u$, then no liability is the u-type's preferred rule. Suppose that $\pi\to 0$ and nearly every entrepreneur is uninformed. In the limit, there is no l-type to deter so the private benefit of deterrence is negligible. The private cost of liability is significant, however, since court error implies non-meritorious lawsuits will be brought against the u-type, which involve expected legal cost of $q\gamma\lambda\overline{d}$. Thus, when π is small, the u-type prefers no liability: $d_u^*=0$. When π is large, however, the u-type's private benefit of deterring the l-types outweighs the costs and $d_u^*=\overline{d}$.

5.2 Divergence Between Private and Social Incentives

Comparing Proposition 2 and Proposition 3 reveals that the u-type entrepreneur's ideal liability rule diverges from the social planner's in a systematic way. The divergence stems from the fact that the u-type does not care about any rent captured by the l-type and the lawyers, while the social planner does. That is, the returns of the l-type and the lawyers are included in the social planner's calculus, but not in the calculus of the self-interested u-type. As a consequence, the u-type's private incentive to impose liability may be either stronger or weaker than the social planner's, $\widehat{\pi}_s>\widehat{\pi}_u$ or $\widehat{\pi}_s<\widehat{\pi}_u$. Comparing conditions (13) and (15), the u-type's private incentive to impose liability $d=\overline{d}$ defined in (4) is weaker than the social planner's if and only if

$$(1-\pi)q(\gamma-\gamma_0)\lambda\overline{d}>\pi q[(1-\alpha^*(0,\pi))x_l-e] \tag{18}$$

where $\overline{d}$ is implicitly defined by (3) and (4) and $\alpha^*(0, \pi)$ is defined in (16).[56]

This expression is intuitive. The left-hand side of (18) represents the lawyers' rent, from the ex ante perspective, when $d = \overline{d}$ and the l-type is fully deterred. Importantly, the rents captured by the lawyers do not generate any direct loss of social welfare, as the well-being of the lawyers is included in the social welfare function. However, these rents do have a negative impact on the u-type's return, as investors will demand a larger equity stake to compensate for higher legal expenses (and to break even). With the l-type fully deterred, any increase in the equity stake (α) directly affects the u-type's profit. The right-hand side (18) represents the l-type's rent, from the ex ante perspective, when $d = 0$ and the l-type is completely undeterred ($\beta^* = 1$). These rents are neutral from a social-welfare perspective, but adversely affect the l-type's return. So (18) tells us that the u-type's private incentive to impose liability is socially insufficient if and only if the rent captured by the lawyers when $d = \overline{d}$ exceeds the rent captured by the l-types when $d = 0$.

Corollary 1. *(Divergence Between Private and Social Incentives.) If the market for legal services is competitive, $\gamma = \gamma_0$, then the u-type's private incentive to impose liability is socially excessive, $\widehat{\pi}_u < \widehat{\pi}_s$. If the market for legal services is not competitive, $\gamma > \gamma_0$, there exists a unique court-error rate $\widehat{\lambda} \in (0, 1]$ where the u-type's private incentive to impose liability is socially insufficient, $\widehat{\pi}_u > \widehat{\pi}_s$, if and only if $\lambda > \widehat{\lambda}$.*

Corollary 1 shows that when courts are more prone to error $\lambda > 0$ and the lawyers earn rents (i.e., the market for legal services is less-than-fully competitive), then the u-type's private incentive to impose liability may be weaker than the social incentive. To understand why, recall that when $d = \overline{d}$ and there is full deterrence, the social cost of litigation reflects the opportunity cost of the lawyers' time, $(1 - \pi)q\gamma_0\lambda\overline{d}$, while the u-type's private cost reflects the legal fees, $(1 - \pi)q\gamma\lambda\overline{d}$. Thus, the private cost of litigation exceeds the social cost of litigation by $(1-\pi)q(\gamma-\gamma_0)\lambda\overline{d} > 0$. The left-hand side, which represents the lawyers' rents, is positive when $\lambda > 0$ and $\gamma > \gamma_0$, is an increasing function of λ, and is a decreasing function of γ_0. As the court becomes more error-prone and the size of rent captured by the lawyers gets larger, the u-type will be less inclined to impose liability on investors, relative to the social planner.

[56] $\overline{d}$ depends on γ and λ and $\alpha^*(0, \pi)$ is independent of γ and λ. In Appendix B, we show that, when the entrepreneur is personally liable, the size of damages necessary to achieve full deterrence is smaller, i.e., $\overline{d} > \overline{d}_{EL}$, and the amount of rent captured by the lawyers under full deterrence ($(1 - \pi)q(\gamma - \gamma_0)\lambda\overline{d}_{EL}$) is smaller. This, in turn, makes the inequality less likely to be satisfied and the u-type is more likely to opt into liability.

5.3 Liability Waiver

The previous subsection demonstrated that the u-type's ideal liability rule diverges from the social planner's ideal rule in a systematic way. In this section, we extend these results to consider the entrepreneurs incentive to waive liability. As above, the participating l-type would mimic the u-type. We first start with the straightforward case of choosing between full liability of $d = \overline{d}$ and no liability ($d = 0$). We then extend the analysis and discuss the social and private incentive to opt out of any liability ($d > 0$).

To begin, consider choosing (either by the social planner or the u-type) between a legal regime where the damages are set at the full-deterrence threshold, $d = \overline{d}$, defined in (4), and no liability ($d = 0$). If (18) holds, then we have $\widehat{\pi}_s < \widehat{\pi}_u$. In that case, if $\pi \in (\widehat{\pi}_s, \widehat{\pi}_u)$, the u-type has a private incentive to choose $d = 0$ over $d = \overline{d}$, while the society is better off with $d = \overline{d}$. The private incentive to waive liability is socially excessive. Conversely, if (18) does not hold, then we have $\widehat{\pi}_u < \widehat{\pi}_s$. In this case, if $\pi \in (\widehat{\pi}_u, \widehat{\pi}_s)$, the u-type will embrace liability ($d = \overline{d}$), while the society is better off if liability is waived ($d = 0$). The private incentive to waive liability is socially insufficient. On the other hand, when $\pi \leq min\{\widehat{\pi}_s, \widehat{\pi}_u\}$, both the social planner and the u-type will prefer no liability ($d = 0$) over full liability ($d = \overline{d}$), whereas when $\pi \geq max\{\widehat{\pi}_s, \widehat{\pi}_u\}$, both will choose full liability over no liability. In these outside regions, private and social incentives are aligned when choosing between full liability and no liability.

What if the choice is between *any* liability ($d > 0$) and no liability ($d = 0$)? Building on the results from the previous section, we can make general statements about liability waivers when the damages award is not set exactly at the full-deterrence threshold ($d \neq \overline{d}$). That is, conditional on any $d > 0$, we ask whether the u-type will have an incentive to waive liability (choose $d = 0$ over $d > 0$) and whether such an incentive is consistent with maximizing social welfare. We start with a formal statement in the following proposition.

Proposition 4. *(General Incentive to Waive Liability.) Given any liability $d > 0$, the social planner's and the u-type's incentive to waive liability (i.e., choose $d = 0$) is given by the following.*

1. *Social Planner's Incentive. If $\pi < \widehat{\pi}_s$, the social planner will always waive liability. If $\pi \geq \widehat{\pi}_s$, $\exists$ $\underline{\delta}_s(\pi) \in [\underline{d}(\pi), \overline{d}]$ and $\overline{\delta}_s(\pi) \geq \overline{d}$, such that the social planner will not waive liability if $d \in [\underline{\delta}_s(\pi), \overline{\delta}_s(\pi)]$ and waive liability otherwise. When $\pi > \widehat{\pi}_0$, $\underline{\delta}_s(\pi) = 0$ and $\overline{\delta}_s(\pi) = \frac{(1-e/x_l)\overline{x}-c}{q\lambda\gamma_0}$; and $\underline{\delta}_s(\widehat{\pi}_s) = \overline{\delta}_s(\widehat{\pi}_s) = \overline{d}$.*

2. *The u-type's Incentive. If $\pi < \widehat{\pi}_u$, the u-type will always waive liability. If $\pi \geq \widehat{\pi}_u$, $\exists\ \underline{\delta}_u(\pi) \leq \overline{d}$ and $\overline{\delta}_u(\pi) \geq \overline{d}$, such that the u-type will not waive liability if $d \in [\underline{\delta}_u(\pi), \overline{\delta}_u(\pi)]$ and waive liability otherwise. When $\pi > \widehat{\pi}_0$, $\underline{\delta}_u(\pi) = 0$ and $\overline{\delta}_u(\pi) = \frac{(1-e/x_l)\overline{x}-c}{q\lambda\gamma}$; and $\underline{\delta}_u(\widehat{\pi}_u) = \overline{\delta}_u(\widehat{\pi}_u) = \overline{d}$.*

While the statements in the proposition are a bit involved, the main idea is fairly straightforward. For both the social planner and the u-type, the incentive to waive liability (and choose $d = 0$, instead) depends foremost on whether π is bigger or smaller than $\widehat{\pi}_s$ or $\widehat{\pi}_u$, respectively. Foremost, for the social planner, we know from Proposition 2 that, when $\pi < \widehat{\pi}_s$ the social welfare is decreasing with respect to d when $d > 0$. Hence, whenever $d > 0$, the social welfare increases by opting out of liability (i.e., by choosing $d = 0$). The story is comparable for the u-type: from Proposition 3, we know that the u-type's expected profit is maximized with $d = 0$ when $\pi < \widehat{\pi}_u$. In short, the social planner will always waive liability when $\pi < \widehat{\pi}_s$ and, similarly, the u-type will always waive liability when $\pi < \widehat{\pi}_u$.

On the other hand, when $\pi \geq \widehat{\pi}_s$ for the social planner (or $\pi \geq \widehat{\pi}_u$ for the u-type), whether the social planner (or the u-type) will waive liability depends on how far d deviates from $\overline{d}$. We know that in these respective regions, for both the social planner and the u-type, the optimal liability is given by $d = \overline{d}$: the social welfare and the u-type's expected profit are maximized with $d = \overline{d}$. Intuitively, then, when the size of liability (d) doesn't deviate "too much" from $\overline{d}$, the social planner and the u-type will not waive liability. Conversely, when d is substantially different from $\overline{d}$, they will waive liability and choose $d = 0$, instead. In Proposition 4, these are expressed using the respective sets of thresholds: ($\underline{\delta}_s(\pi)$, $\overline{\delta}_s(\pi)$) for the social planner and ($\underline{\delta}_u(\pi)$, $\overline{\delta}_u(\pi)$) for the u-type, where $\underline{\delta}_s(\pi) \leq \overline{d} \leq \overline{\delta}_s(\pi)$ and $\underline{\delta}_u(\pi) \leq \overline{d} \leq \overline{\delta}_u(\pi)$. See the dashed lines in Figure 2. For instance, if $d \in [\underline{\delta}_s(\pi), \overline{\delta}_s(\pi)]$ (or $d \in [\underline{\delta}_u(\pi), \overline{\delta}_u(\pi)]$), the social planner (or the u-type) will not waive liability, whereas if $d > \overline{\delta}_s(\pi)$ or $d < \underline{\delta}_s(\pi)$ (or $d > \overline{\delta}_u(\pi)$ or $d < \underline{\delta}_u(\pi)$), the social planner (or the u-type) will waive liability. With these results, we can also see how the u-type's incentive to waive liability differs from the social planner's. The formal statement is presented in the following corollary.

Corollary 2. *If $\pi > \widehat{\pi}_0$, then $\overline{\delta}_u(\pi) < \overline{\delta}_s(\pi)$. When $\pi > \widehat{\pi}_0$ and $d \in [\overline{\delta}_u(\pi), \overline{\delta}_s(\pi)]$, the u-type will waive liability while the social planner will not: u-type's incentive to waive liability $d > 0$ is socially excessive. When $\widehat{\pi}_s < \widehat{\pi}_u$, if $\pi \in [\widehat{\pi}_s, \widehat{\pi}_u)$ and $d \in [\underline{\delta}_s(\pi), \overline{\delta}_s(\pi)]$, the social planner will waive liability while the u-type will not: u-type's incentive to waive liability $d > 0$ is socially insufficient. When $\widehat{\pi}_s > \widehat{\pi}_u$, if $\pi \in [\widehat{\pi}_u, \widehat{\pi}_s)$ and $d \in [\underline{\delta}_u(\pi), \overline{\delta}_u(\pi)]$, the u-type will waive liability while the social planner will not: u-type's incentive to waive liability $d > 0$ is socially excessive.*

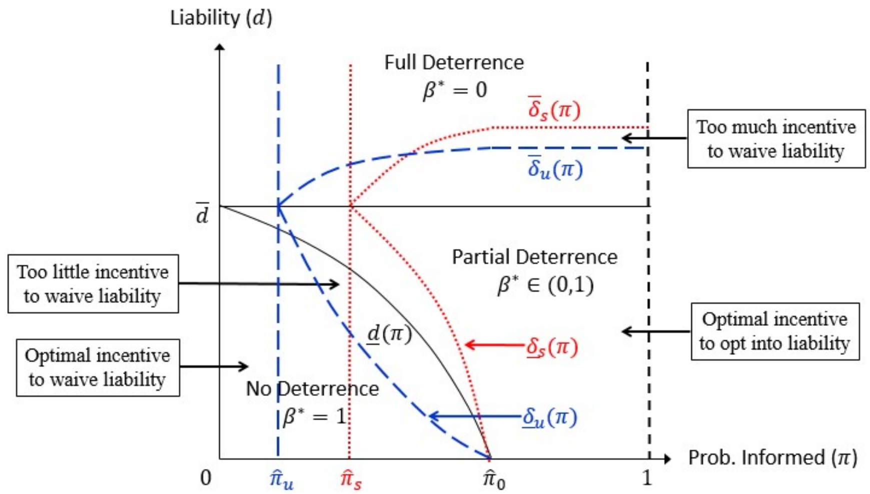

Figure 2: Divergence Between Private and Social Incentive to Waive Liability

The results of the corollary follow directly from Proposition 4. The corollary demonstrates that the social planner's and the u-type's incentives to waive liability do not necessarily align. Foremost, when $\pi > \widehat{\pi}_0$, while both the social planner and the u-type will waive liability only when d is sufficiently larger than $\overline{d}$ ($d > \overline{d}_s > \overline{d}$ for the social planner and $d > \overline{d}_u > \overline{d}$ for the u-type), the u-type will generally have too much incentive to waive liability. See Figure 2. When $\pi \leq \widehat{\pi}_0$, the incentive alignment will depend (among others) on whether $\widehat{\pi}_s$ is smaller or bigger than $\widehat{\pi}_u$, which, in turn, depends on λ and $\gamma - \gamma_0$, as was shown in Corollary 1. From Corollary 1, we know that when $\gamma - \gamma_0 > 0$ and as λ gets larger, we are more likely to have $\widehat{\pi}_s < \widehat{\pi}_u$. In that case, when $\pi \in [\widehat{\pi}_s, \widehat{\pi}_u)$ and $d \in [\underline{\delta}_s(\pi), \overline{\delta}_s(\pi)]$, even though it is socially optimal to not waive liability, the u-type, finding litigation too privately costly, will waive liability. The opposite will occur with small λ: when $\pi \in [\widehat{\pi}_u, \widehat{\pi}_s)$ and $d \in [\underline{\delta}_u(\pi), \overline{\delta}_u(\pi)]$, the u-type will opt into liability even though litigation is socially wasteful and liability waiver is socially optimal. Figure 2 presents the case of $\widehat{\pi}_u < \widehat{\pi}_s$.

6 Positive and Normative Implications

In addition to the implications discussed in the previous sections on liability waiver, the analysis delivers a number of positive and normative (policy) implications. The first set of (mostly positive) implications is with respect to initial public offering and a possible way of estimating the size of the deterrence effect.[57] As the analysis shows,

[57] We are thinking of IPO "mis-pricing" somewhat expansively. Though some think of IPO under and over-pricing to be based on the movement of the stock price on the day of the IPO, we measure

foremost, that the relationship between the level of deterrence (the size of d) and IPO under or over-pricing depends on the type of equilibrium (i.e., full deterrence, partial deterrence, no deterrence). In the partial deterrence region (with $\beta^* \in (0,1)$), as shown in Proposition 1 (Case 2), as the level of deterrence gets weaker (d gets smaller), because the probability with which the l-type participates in financing (β^*) gets (weakly) higher, over-pricing at the initial offerings becomes more frequent (while the fraction IPOs that is under-priced gets lower).[58] At the same time, while the frequency of over-pricing goes up with lower deterrence, as the rational investors begin to discount the stock more (i.e., demand a larger α in the model), the (average) size of over-pricing should become smaller (and the (average) size of under-pricing becomes larger).

On the other hand, in the regions where the l-type's participation is insensitive to the changes in d, either due to full deterrence or no deterrence, the frequency of under-pricing will remain (relatively) constant in the respective region (as shown in Proposition 1 (Cases 1 and 3)). With full deterrence ($\beta^* = 0$), under and over-pricing frequency will be determined by the realized revenue of the uniformed type (x_h or x_l), whereas with no deterrence ($\beta^* = 1$), the frequency of over-pricing increases due to the presence of the l-type. At the same time, however, the size of over and under-pricing will still be affected by the degree of liability (d). As liability gets stronger, because the size of litigation deadweight loss increases (as shown in Lemmas 1 and 2), the size of under-pricing will get bigger (and over-pricing smaller) in both regions as investors would demand a lower IPO price as a compensation for the future litigation cost. In sum, incorporating the liability issue into the initial public offering scenario offers more nuanced understanding of the IPO process. The analysis also offers a way of (indirectly) measuring the level of deterrence, i.e., by estimating the frequency and size of over-pricing (or under-pricing) at IPOs.

The second set of implications are the factors that correlate with better or worse deterrence. Foremost, the model shows that when the size of litigation recovery

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the time period from the date of the IPO to the date of the discovery of non-disclosure, which, in theory, can be quite short.

[58]Using a sample of IPOs from 1965 through 2005, Lowry, Officer, and Schwert (2010) show that while on average, IPOs are under-priced, about one-third of IPOs are over-priced (had a negative return, measured over twenty trading days after the IPO). Our model is constructed using the fraction of the firm (α) sold to the investors, but we can easily translate the result using per-share price. Suppose both the l-type and the u-type firms have n total number of shares and sell m shares to the outside investors, so that $m/n = \alpha$. Conditional on non-disclosure, if the investors' expected valuation of the firm is v, we get $p = v/n$, where p stands for the IPO price. We also have $v = \gamma x_l + (1-\gamma)\overline{x}$, where γ stands for the conditional probability of facing the l-type (which depends on β). As γ rises (when β rises), the fraction of IPOs that are over-priced increases but because v falls, the size of over-pricing (measured by $(v - x_l)/n$) decreases.

(d) is small and/or the degree of adverse selection (π) is small, the firms (and the entrepreneurs) are much less likely to be deterred (they participate with a high β^*).[59] As the Facebook example in the introduction shows, most of securities class actions are settled and many are settled for relatively small amount (compared to the potential recovery).[60] If we think that the investors expect to receive relatively little from future securities litigation ($d \leq \underline{d}(\pi)$) or they believe that the problems of adverse selection isn't severe (π is small such that $d \leq \underline{d}(\pi)$), they expect that the damages will produce little or no deterrence and will simply take strategic non-disclosure as given. On the other hand, even when expected recovery may be moderate, when the investors believe that the problems of strategic non-disclosure are substantial, we would observe more frequent litigation and also better deterrence.

The final set of implications deals with conditions under which firms' preference (demand) for a private ordering regime (under which they can tailor their own liability system) is aligned with social welfare. Although there can be many variations on the private ordering regime, here, we can focus on a few notable mechanisms that have received much attention recently. As alluded to briefly in the introduction and the legal background section, in recent years, there have been two salient private ordering proposals: (1) mandatory individual arbitration proposal and (2) federal forum proposal (which restricts Section 11 lawsuits only to federal courts). While the mandatory individual arbitration provision has been thought of as a de facto liability waiver, federal forum provision restricts Section 11 lawsuits to federal (and not state) courts.

With respect to the mandatory individual arbitration provision, as we saw earlier, whether the private incentive to waive liability is aligned with social welfare depends on several factors, such as the amount of rent captured by the lawyers in the litigation system ($\gamma - \gamma_0$), size of damages (d), the likelihood of court error (λ), and the probability that the firm raising capital through equity sale has private information (π). As shown in Corollaries 1 and 2 and Proposition 4, when the size of lawyers' rent or the likelihood of false positives grow, for instance, firms become more likely to prefer a liability waiver, whereas with less lawyers' rent and a more accurate adjudication system, firms may be too willing to opt into a liability system. We would assume that these factors are not the same across all firms, and the model tells us how firm

[59] Two points support the statement. First, from Proposition 1, we know that, in the partial deterrence equilibrium, $\frac{\partial \beta^*}{\partial d} < 0$ and $\frac{\partial \beta^*}{\partial \pi} < 0$. Second, conditional on $d < \overline{d}$, as π decreases, we get $d \leq \underline{d}$, thereby moving from partial deterrence region to no deterrence.

[60] According to Bohn and Choi (1996), over 90% of securities class actions end in settlement. See also Choi, Choi, and Pritchard (2022). Lowry and Shu (2002) shows that the average settlement size, which did not include litigation costs, is about 11% of the total proceeds raised at IPOs.

characteristics correlate with their incentive to either waive or stay in the liability system.

Compared to a mandatory individual arbitration provision, the latter private ordering mechanism, a federal forum provision, operates quite differently. Instead of banning class actions, the provision requires the plaintiffs to bring a Section 11 claim only in a federal court. While a more detailed discussion over how such a provision operates is beyond the scope of this paper,[61] from the model, we can think of the provision as not affecting the size of liability (d), but rather the procedural elements, which could affect elements such as the rate of false positivity and the lawyer's rent. From Figure 1, we can think of fixing a point on the $\pi - d$ plane, while affecting λ and γ. It is fairly straightforward to show that, conditional on d and π, the u-type will be in favor of reducing λ and γ, and the u-type's choice will generally be consistent with improving social welfare. In other words, federal forum provisions are less likely to raise concerns over divergence between social and private incentives.

7 Conclusion

Under the current legal system, when a firm sells its stock (or other securities) to outside investors to raise capital, the firm can be held liable to the investors for non-disclosure of material information. Although the general objective of the liability system is to discourage firms from withholding material information and to promote better functioning capital markets, including the IPO market, the system has also attracted criticism for being inefficient and too costly. Is firm liability an effective deterrent? Do the benefits of firm liability outweigh the costs? Instead of having a one-size-fits-all mandatory system, should the firm be able to design their own liability system?

The paper has analyzed how the liability system affects a firm's incentive to disclose material information using a simple game-theoretic model. In the model, the firm can sell stock to the outside investors to raise capital while deciding whether to withhold material information from the prospective investors, and the investors can bring a lawsuit against the firm to recover damages. Investors are rational and forward looking, and anticipate being plaintiffs in future litigation in case non-disclosure is uncovered. The paper has shown that the equilibrium (non-disclosure and financing) depends on a number of factors, including the amount of personal capital that the entrepreneur needs to invest, the size of damages that the investors can recover, the

[61] For a more detailed analysis, see Aggarwal, Choi, and Eldar (2020).

frequency with which the entrepreneur is privately informed (the degree of adverse selection), and the cost of litigation, including both the lawyers' fees and court error.

Building on the analysis, the paper examined several policy proposals, in particular, whether to allow firms to choose their own liability system with a liability waiver. We showed that the firms' choice of liability system may or may not align with the socially-optimal choice. The reason for the divergence comes from the fact that while the firms care about maximizing their own profits (and not about disclosure per se), social welfare depends on deterring strategic non-disclosure and minimizing the deadweight loss from litigation and inefficient financing. The analysis showed that the firms may have a too much or too little incentive to opt out of liability to reduce their cost of capital. The divergence depends, among others, on the amount of rent captured by the lawyers and also on the likelihood of court error. For instance, as the lawyers capture more rent and the court is more likely to find innocent non-disclosing firms liable, the firms may have too much incentive to waive liability. In such cases, disallowing liability waiver can actually increase social welfare.

Our simple model abstracted from several relevant factors, including externalities on the market, investors' incentive to bring lawsuits (including lawsuit credibility), lawsuit against "gatekeepers" (such as underwriters, accountants, and lawyers), potential non-disclosure and manipulation by corporate managers in the secondary market, and the bounded rationality of investors. It is possible that the presence of a liability system can affect not just one firm's incentive to disclose but the "integrity" of the entire stock market. Also, one salient issue is managers' incentive to misreport to the market (e.g., "cook the books"), even in the absence of capital raising. Other factors, such as investor myopia and settlement, can also come into play. When these factors are taken into account, the private incentives to opt out of costly litigation may be socially excessive rather than socially insufficient. The investors' willingness to participate in the equity market will also be affected.

With respect to lawsuit credibility, given the drop in stock value, when an investor (such as a large institutional investor) bears a disproportionately large portion of the litigation cost, the large institutional shareholder may decline to bring a lawsuit against the firm, which, in turn, can undermine the deterrence effect of the liability system.[62] Finally, when the investors can bring suit against other IPO agents, such

[62]Griffith and Lund (2020) and Platt (2020) found that even though shareholder litigation offers potential benefits for large mutual funds, most class actions are brought by small institutional or retail investors. With buy-and-hold strategies, large mutual funds have essentially "forfeited" their right to bring litigation. See also Webber (2015). Platt (2020) documents an "enforcement shortfall" by the big three institutional investors. Bebchuk and Hirst (2019) similarly show that mutual funds do not serve as lead plaintiffs in shareholder class actions.

as underwriters, accountants, and lawyers, having such a gatekeeper can potentially lead to better information production (where the agents can uncover more information) but, at the same time, create a possibility of collusion between the firm and the gatekeeper. The possibility of holding the gatekeepers liable raises questions on whether the current defenses (based, for instance, on "due diligence") are normatively desirable. These issues are topics for future research.

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Appendix A: Proofs

Proof of Lemma 1. (Full-Deterrence Threshold.) Note that if $\beta^* = 0$, $\overline{\alpha}(d)$ and $\overline{d}$ defined in (3) and (4) satisfy equilibrium conditions (1) and (2) with equality.

Suppose that $d > \overline{d}$ defined in (4). We will prove that $\beta^* = 0$ by contradiction. Suppose not: $\beta^* > 0$. Condition (1) implies that $(1-\alpha^*)(x_l - d) - e \geq 0$. Since $(1-\overline{\alpha})(x_l - \overline{d}) - e = 0$ by construction and $d > \overline{d}$, we must have $\alpha^* < \overline{\alpha}$. Since $\beta^* > 0$ by assumption, condition (1) also implies that $\alpha^*(x_l - d) \leq x_l - d - e$. Substituting this into (2) and canceling terms gives

$$(1-\pi)(\alpha^*(\overline{x} - q\lambda d) - c + q\lambda(1-\gamma)d) + \pi q \beta^*(x_l - k - \gamma d) \geq 0.$$

Solving for α^*, we get:

$$\alpha^* \geq \frac{c - q\lambda(1-\gamma)d}{\overline{x} - q\lambda d} + \frac{\pi q \beta^*}{1-\pi} \cdot \frac{k + \gamma d - x_l}{\overline{x} - q\lambda d}.$$

The first term on the right hand side is $\overline{\alpha}(d)$ defined in (3) and the second term is positive. Therefore $\alpha^* > \overline{\alpha}(d)$, a contradiction. Thus, $\beta^* = 0$ for $d > \overline{d}$.

We now explore the comparative statics for equity stake $\overline{\alpha}(d)$ when $d > \overline{d}$. Since $\beta^* = 0$, (3) becomes:

$$\alpha^*(\overline{x} - q\lambda d) - c + q(1-\gamma)\lambda d = 0. \tag{19}$$

Totally differentiating (19) with respect to α^* and d gives: $(\overline{x} - q\lambda d)\Delta\alpha^* + q\lambda(1 - \alpha^* - \gamma)\Delta d = 0$. The first coefficient is clearly positive. Using equation (3), $1 - \alpha^* - \gamma = \frac{(1-\gamma)\overline{x} - c}{\overline{x} - q\lambda d}$. Using Assumptions 1 and 3 verifies that the numerator is positive. Therefore $\Delta\alpha^*/\Delta d < 0$. Totally differentiating (19) with respect to α^* and λ gives $(\overline{x} - q\lambda d)(\Delta\alpha^*) + q(1-\gamma)d(\Delta\lambda) = 0$. Both coefficients are positive so $\Delta\alpha^*/\Delta\lambda < 0$. Totally differentiating (19) with respect to α^* and γ gives $(\overline{x} - q\lambda d)(\Delta\alpha^*) - q\lambda d(\Delta\gamma) = 0$. Since the first coefficient is positive and the second negative, $\Delta\alpha^*/\Delta\gamma > 0$.

We now explore comparative statics for threshold $\overline{d}$. Rewrite (3) as $1 - \overline{\alpha} = \frac{\overline{x} - c - q\gamma\lambda\overline{d}}{\overline{x} - q\lambda\overline{d}}$ and (4) as $(x_l - \overline{d})(1 - \overline{\alpha}) - e = 0$. Plugging the former into the latter, and multiplying by $\overline{x} - q\lambda\overline{d}$, gives:

$$(x_l - \overline{d})(\overline{x} - c - q\gamma\lambda\overline{d}) - e(\overline{x} - q\lambda\overline{d}) = 0. \tag{20}$$

The threshold $\overline{d}$ is implicitly defined by this quadratic equation. Since (20) does not include π, $\Delta\overline{d}/\Delta\pi = 0$. When we totally differentiate (20) with respect to $\overline{d}$ and λ, we get:

$$[-(\overline{x}-c-q\gamma\lambda\overline{d})-q\gamma\lambda(x_l-\overline{d})+eq\lambda]\Delta\overline{d}+[-q\gamma\overline{d}(x_l-\overline{d})+eq\overline{d}]\Delta\lambda=0.$$

Adding and subtracting e in the first set of brackets, and using $k=c+e$, the equation becomes:

$$[-(\overline{x}-k-q\gamma\lambda\overline{d})-q\gamma\lambda(x_l-\overline{d})-(1-q\lambda)e]\Delta\overline{d}+q\overline{d}(e-\gamma(x_l-\overline{d}))\Delta\lambda=0.$$

Assumption 2 implies that the coefficient on $\Delta\overline{d}$ is negative. Assumption A3 that $\gamma<e/x_l$ implies the coefficient on $\Delta\lambda$ is positive since $e-\gamma(x_l-\overline{d})>e-(e/x_l)(x_l-\overline{d})=(e/x_l)\overline{d}>0$. Therefore $\Delta\overline{d}/\Delta\lambda>0$. Totally differentiate (20) with respect to $\overline{d}$ and γ:

$$[-(\overline{x}-k-q\gamma\lambda\overline{d})-q\gamma\lambda(x_l-\overline{d})-(1-q\lambda)e](\Delta\overline{d})-(x_l-\overline{d})q\lambda\overline{d}(\Delta\gamma)=0.$$

We just showed that the coefficient on $\Delta\overline{d}$ is negative, and now the coefficient on $\Delta\gamma$ is negative. Therefore $\Delta\overline{d}/\Delta\gamma<0$. Similarly, $\Delta\overline{d}/\Delta e<0$ □

Proof of Lemma 2. (No-Deterrence Threshold.) Suppose $\beta^*=1$ and the l-type is just indifferent between participating and not. From (1) we have $(1-\alpha^*)(x_l-\underline{d})-e=0$ so $\alpha^*(x_l-\underline{d})=x_l-\underline{d}-e$. Substituting this into (5), we get:

$$(1-\pi)[\alpha^*(\overline{x}-q\lambda\underline{d})-c+q(1-\gamma)\lambda\underline{d}]+\pi q[x_l-\underline{d}-e-c+(1-\gamma)\underline{d}]=0$$

$$\iff(1-\pi)(\alpha^*(\overline{x}-q\lambda\underline{d})-c+q(1-\gamma)\lambda\underline{d})+\pi q[x_l-k-\gamma\underline{d}]=0.$$

Solving for α^*, we get:

$$\alpha^*=\frac{c-q(1-\gamma)\lambda\underline{d}}{\overline{x}-q\lambda\underline{d}}+\frac{\pi q}{1-\pi}\cdot\frac{k+\gamma\underline{d}-x_l}{\overline{x}-q\lambda\underline{d}}.$$

This is the equity share demanded by the investors when the l-type is just indifferent and participates for sure ($\beta^*=1$). This may be rewritten as:

$$\alpha^*(\underline{d},\pi)=\overline{\alpha}(\underline{d})+r(\underline{d},\pi)$$

where $\overline{\alpha}(\underline{d})$ is defined in (3) and $r(\underline{d},\pi)$ is the premium defined in (7). Substituting this into (1) gives the implicit formula for $\underline{d}$ in equation (8).

We now show that $\underline{d}(\pi)$ is a decreasing function of π. Rewriting (8),

$$1-\overline{\alpha}(\underline{d})-r(\underline{d},\pi)-\frac{e}{x_l-\underline{d}}=0.$$

Substituting $\overline{\alpha}(\underline{d})$ from (3) and $r(\underline{d}, \pi)$ from (7),

$$1 - \frac{c - q(1-\gamma)\lambda \underline{d}}{\overline{x} - q\lambda \underline{d}} - \frac{\pi q}{1-\pi} \cdot \frac{k + \gamma \underline{d} - x_l}{\overline{x} - q\lambda \underline{d}} - \frac{e}{x_l - \underline{d}} = 0.$$

Multiplying by $\overline{x} - q\lambda \underline{d}$,

$$(\overline{x} - q\lambda \underline{d}) - (c - q(1-\gamma)\lambda \underline{d}) - \frac{\pi q}{1-\pi} \cdot (k + \gamma \underline{d} - x_l) - \frac{e(\overline{x} - q\lambda \underline{d})}{x_l - \underline{d}} = 0.$$

$$(\overline{x} - c - q\gamma\lambda \underline{d}) - \frac{\pi q}{1-\pi} \cdot (k + \gamma \underline{d} - x_l) - \frac{e(\overline{x} - q\lambda \underline{d})}{x_l - \underline{d}} = 0. \tag{21}$$

This equation implicitly defines the full-deterrence threshold, $\underline{d}(\pi)$.

We now prove that $\underline{d}(\pi)$ is decreasing in π. If $\pi = 0$, then the second term in (21) is zero and the equation is the same as (20), so $\underline{d}(0) = \overline{d}$. Totally differentiating (21) with respect to $\underline{d}$ and π, we get:

$$\left[-q\gamma\lambda - \frac{\pi q}{1-\pi} \cdot \gamma - \frac{e(\overline{x} - q\lambda x_l)}{(x_l - \underline{d})^2}\right] \Delta \underline{d} - \frac{q}{(1-\pi)^2} \cdot (k + \gamma \underline{d} - x_l)\Delta\pi = 0.$$

Since the coefficients for $\Delta \underline{d}$ and $\Delta\pi$ are both negative, $\Delta \underline{d}/\Delta\pi < 0$.

We now characterize the threshold $\widehat{\pi}_0$ where $\underline{d}(\pi) > 0$ if and only if $\pi < \widehat{\pi}_0$. Setting $\underline{d} = 0$ in equation (21) and rearranging, $\widehat{\pi}_0$ must satisfy:

$$\frac{1 - \widehat{\pi}_0}{\widehat{\pi}_0 q} = \frac{x_l(k - x_l)}{x_l(\overline{x} - c) - e\overline{x}}. \tag{22}$$

The denominator is positive by Assumption 1. So threshold $\widehat{\pi}_0 \in (0, 1)$ exists.

□

Proof of Proposition 1. (Equilibrium Characterization.)

Case 1. The full deterrence result follows immediately from Lemma 1.

Case 2. The partial deterrence equilibrium $\alpha^*(d, \pi)$ and $\beta^*(d, \pi)$ in (9) and (10) may be found by solving the l-type's indifference condition (1) and the investors' break-even condition (2) simultaneously.

We now show that $\beta^*(d, \pi)$, defined in (10), is a decreasing function of d. Note that denominator of (10), $k + \gamma d - x_l$, is increasing in d. If we prove the numerator is decreasing in d, we are done. Using the formula for $\alpha^*(d,\pi)$ in (9), the numerator of (10) may be written as:

$$\alpha^*(\overline{x} - q\lambda d) - c + q\lambda d(1-\gamma).$$

The slope of the numerator of (10) is:

$$\frac{\partial \alpha^*(d,\pi)}{\partial d}(\overline{x} - q\lambda d) + q\lambda(1-\alpha^* - \gamma).$$

Using (9) we have $\frac{\partial \alpha^*}{\partial d} = \frac{-e}{(x_l-d)^2}$. Substituting this and $1-\alpha^* = e/(x_l - d)$,

$$\begin{aligned}
&\frac{-e}{(x_l-d)^2}(\overline{x} - q\lambda d) + q\lambda\left(\frac{e}{x_l-d} - \gamma\right) \\
&< \frac{-e}{(x_l-d)^2}(\overline{x} - q\lambda d) + q\lambda\left(\frac{e}{x_l-d}\right) \\
&= \frac{-e}{(x_l-d)^2}\left(\overline{x} - q\lambda d - q\lambda(x_l-d)\right) \\
&= \frac{-e}{(x_l-d)^2}\left(\overline{x} - q\lambda x_l\right) < 0.
\end{aligned}$$

This proves that $\beta^*(d,\pi)$ is a decreasing function of d. Since $\beta^*(d,\pi)$ characterized in (10) is proportional to $(1-\pi)/\pi q$, β^* is decreasing in π. By construction, from Lemma 1 when $d=\overline{d}$ then $\beta^*(\overline{d},\pi)=0$ and from Lemma 2 when $d=\underline{d}$ then $\beta^*(\underline{d},\pi)=1$.

Case 3. In the no-deterrence region, the equilibrium $\alpha^*(d,\pi)$ in (11) may be found by setting $\beta^*=1$ in the investors' break-even condition (2) and solving for $\alpha^*(d,\pi)$. We will show that $\alpha^*(d,\pi)$ is decreasing in d. Setting $\beta^*=1$ and totally differentiating the investors' break-even condition (2) with respect to α and d,

$$[(1-\pi)(\overline{x} - q\lambda d) + \pi q(x_l - d)]\Delta\alpha^* + [(1-\pi)q\lambda(1-\alpha^*-\gamma) + \pi q(1-\alpha^*-\gamma)]\Delta d = 0.$$

$$\iff [(1-\pi)(\overline{x} - q\lambda d) + \pi q(x_l - d)]\Delta\alpha^* + (1-\gamma-\alpha^*)[(1-\pi)q\lambda + \pi q]\Delta d = 0.$$

Rearranging, we get:

$$\frac{\Delta\alpha^*}{\Delta d} = -\frac{(1-\gamma-\alpha^*)[(1-\pi)q\lambda + q\pi]}{(1-\pi)(\overline{x} - q\lambda d) + \pi q(x_l - d)}. \tag{23}$$

To show this is negative, we will prove that $1 - \alpha^* - \gamma > 0$. From (11),

$$1 - \gamma - \alpha^* = \frac{(1-\pi)[(1-\gamma)\overline{x} - c] + \pi q[(1-\gamma)x_l - c]}{(1-\pi)(\overline{x} - q\lambda d) + \pi q(x_l - d)} < 0.$$

The denominator is positive, so we need to prove the numerator is positive. A sufficient condition for the numerator to be positive is:

$$\frac{1-\pi}{\pi q} > \frac{c - (1-\gamma)x_l}{(1-\gamma)\overline{x} - c}.$$

Since $\pi < \widehat{\pi}_0$ in Case 3, then using (22) it is sufficient to show

$$\frac{x_l(k - x_l)}{x_l(\overline{x} - c) - e\overline{x}} > \frac{c - (1-\gamma)x_l}{(1-\gamma)\overline{x} - c}. \tag{24}$$

The denominators of both sides are positive under Assumptions 1 and 3. Cross multiplying and canceling terms, this is equivalent to $\gamma < e/x_l$ which is true by Assumption 3. This proves that $\alpha^*(d, \pi)$ is a decreasing function of d. $\square$

Proof of Lemma 3. (Social Welfare Comparative Statics.) In *Case 1* and *Case 3* of Proposition 1, β^* fixed. Hence, the social welfare in (12) is a decreasing function of d. Consider *Case 2*. Some parts of the social welfare function in (12) do not depend on d. The relevant part to examine is:

$$-(1-\pi)q\lambda\gamma_0 d - \pi q\beta^*(k + \gamma_0 d - x_l).$$

Substituting β^* from (10) above, this becomes

$$-(1-\pi)q\lambda\gamma_0 d - (1-\pi)\frac{k + \gamma_0 d - x_l}{k + \gamma d - x_l}\left(\alpha^*(\overline{x} - q\lambda d) - c + q(1-\gamma)\lambda d\right).$$

Dropping the $1 - \pi$ and substituting $\alpha^* = 1 - \frac{e}{x_l - d}$,

$$-q\lambda\gamma_0 d - \frac{k + \gamma_0 d - x_l}{k + \gamma d - x_l}\left((\overline{x} - q\lambda d) - \frac{e}{x_l - d}(\overline{x} - q\lambda d) - c + q(1-\gamma)\lambda d\right)$$

$$= -q\lambda\gamma_0 d - \frac{k + \gamma_0 d - x_l}{k + \gamma d - x_l}\left(\overline{x} - c - q\gamma\lambda d - \frac{e(\overline{x} - q\lambda d)}{x_l - d}\right)$$

$$= \left(\frac{-q\gamma_0\lambda d(k - x_l) + q\gamma\lambda d(k - x_l)}{k + \gamma d - x_l}\right) - \frac{k + \gamma_0 d - x_l}{k + \gamma d - x_l}\left(\overline{x} - c - \frac{e(\overline{x} - q\lambda d)}{x_l - d}\right).$$

Combining terms in the first bracket,

$$= \left\{ \frac{q\lambda d(k-x_l)(\gamma-\gamma_0)}{k+\gamma d-x_l} \right\} - \left[\frac{k+\gamma_0 d-x_l}{k+\gamma d-x_l} \right] \left(\overline{x} - c - \frac{e(\overline{x}-q\lambda d)}{x_l-d} \right).$$

The first term in curly brackets is increasing in d. Since $\gamma_0 < \gamma$, the second term in square brackets is decreasing in d. Finally, the third term in brackets is decreasing in d. This establishes that social welfare is an increasing function of d in the partial deterrence region. This completes the proof. □

Proof of Proposition 2. (Socially-Optimal Liability Rule.) Suppose $\pi \geq \widehat{\pi}_0$. From Lemma 2, we have $\underline{d}(\pi) = 0$. Lemma 3 establishes that social welfare is increasing in d when $d \in [0, \overline{d}]$ (partial deterrence) and decreasing in d when $d > \overline{d}$ (full deterrence). Therefore the socially-optimal damage award $d_s^* = \overline{d}$.

Suppose $\pi < \widehat{\pi}_0$. From Lemma 2, we have $\underline{d}(\pi) > 0$. Lemma 3 establishes that social welfare is decreasing in d when $d \in [0, \underline{d})$ (no deterrence), increasing in d when $d \in [\underline{d}, \overline{d}]$ (partial deterrence), and decreasing in d when $d > \overline{d}$ (full deterrence). Therefore the socially-optimal damage award $d_s^* \in \{0, \overline{d}\}$.

Using the social welfare function in (12), society prefers $d = 0$ and no deterrence ($\beta^* = 1$) to $d = \overline{d}$ and full deterrence ($\beta^* = 0$) if:

$$(1-\pi)(\overline{x}-k)+\pi(1-q)(x_h-k)+\pi q(x_l-k) > (1-\pi)(\overline{x}-k-q\lambda\gamma_0\overline{d})+\pi(1-q)(x_h-k).$$

Terms cancel and this becomes

$$\pi q(k-x_l) < (1-\pi)q\lambda\gamma_0\overline{d}. \tag{25}$$

The left-hand side is the social loss if $d = 0$ and there is no deterrence. In this case, the l-types are undeterred so the welfare loss is $k - x_l$. The right-hand side is the welfare loss if there is full deterrence. In this case, the welfare loss reflects the opportunity cost of the lawyer's time. Rearranging (25), the social planner prefers $d = 0$ to $d = \overline{d}$ if and only if $\pi < \widehat{\pi}_s$ defined in (14) in the text. Since the right-hand side of (14) is positive we have $\widehat{\pi}_s > 0$. Since social welfare is strictly increasing in d when $\pi = \widehat{\pi}_0$ and $d \in [0, \overline{d})$, we have $\widehat{\pi}_s < \widehat{\pi}_0$ (by continuity). □

Proof of Lemma 4. (Private Welfare Comparative Statics.) The expected returns of the u-type, the l-type (if they participate), and the lawyers, respectively, are:

$$\Pi_u(d,\pi) = (1-\pi)[(1-\alpha^*(d,\pi))(\overline{x}-q\lambda d)-e], \tag{26}$$

$$\Pi_l(d,\pi) = \pi q[(1-\alpha^*(d,\pi))(x_l-d)-e], \tag{27}$$

$$\Pi_a(d,\pi) = (1-\pi)(\gamma-\gamma_0)q\lambda d + \pi q\beta^*(d,\pi)(\gamma-\gamma_0)d. \tag{28}$$

Case 1. $\beta^*(d,\pi)=0$. Since the l-type does not participate, the l-type's return is zero and independent of d. From (28), the attorney's return is increasing in d. Since social welfare is decreasing in d (Lemma 3), the u-type's expected return is decreasing in d.

Case 2. $\beta^*(d,\pi)\in(0,1)$. Since the l-type is randomizing between participating and not, their expected return is zero and independent of d. We will now show that the u-type's expected return is increasing in d. Substituting α^* from (9) in Proposition 1 into (26), we get:

$$\Pi_u(d,\pi) = (1-\pi)\left[\frac{e(\overline{x}-q\lambda d)}{x_l-d} - e\right] = (1-\pi)\left[\frac{(\overline{x}-x_l)+(1-q\lambda)d}{x_l-d}\right]e.$$

Since the denominator is decreasing in d and the numerator is increasing in d, we have that the u-type's payoff is increasing in d.

Case 3. In equilibrium, $\beta^*(d,\pi)=1$. The attorneys' expected return in (28) is increasing in d. Now consider the l-type's expected return in (27). Differentiating with respect to d, we get:

$$\pi q\left[-\frac{\Delta\alpha^*}{\Delta d}(x_l-d)-(1-\alpha^*)\right].$$

Since $\Delta\alpha^*/\Delta d<0$ from Proposition 2, the first term in the brackets is positive. The second term is negative. Using the formula for $\Delta\alpha^*/\Delta d$ from (23) above, this becomes:

$$\begin{aligned}
&\pi q\left[\frac{(1-\gamma-\alpha^*)[(1-\pi)q\lambda+q\pi]}{(1-\pi)(\overline{x}-q\lambda d)+\pi q(x_l-d)}(x_l-d)-(1-\alpha^*)\right]\\
&=\pi q\left[\frac{(x_l-d)[(1-\pi)q\lambda+q\pi]}{(1-\pi)(\overline{x}-q\lambda d)+\pi q(x_l-d)}(1-\gamma-\alpha^*)-(1-\gamma-\alpha^*)-\gamma\right]\\
&=\pi q\left[\frac{(x_l-d)[(1-\pi)q\lambda+q\pi]-(1-\pi)(\overline{x}-q\lambda d)-\pi q(x_l-d)}{(1-\pi)(\overline{x}-q\lambda x_l)+q(x_l-d)[(1-\pi)\lambda+\pi]}(1-\gamma-\alpha^*)-\gamma\right]\\
&=\pi q\left[\frac{-(1-\pi)(\overline{x}-q\lambda x_l)(1-\gamma-\alpha^*)}{(1-\pi)(\overline{x}-q\lambda x_l)+q(x_l-d)[(1-\pi)\lambda+\pi]}-\gamma\right].
\end{aligned}$$

From the proof of Proposition 1 Case 3, $1-\gamma-\alpha^*>0$. Therefore the l-type's return is decreasing in d.

Now, consider the u-type's expected return in (26). Differentiating with respect to d, we get:

$$(1-\pi)\left[-\frac{\Delta\alpha^*}{\Delta d}(\overline{x}-q\lambda d)-q\lambda(1-\alpha^*)\right].$$

When we substitute the expression for $\frac{\Delta\alpha^*}{\Delta d}$ in (23) from above, the expression becomes:

$$(1-\pi)\left[\frac{q(1-\gamma-\alpha^*)[(1-\pi)\lambda+\pi]}{(1-\pi)(\overline{x}-q\lambda d)+\pi q(x_l-d)}(\overline{x}-q\lambda d)-q\lambda(1-\alpha^*)\right].$$

When we (i) pull the q out, (ii) rearrange the numerator of first term, and (iii) add and subtract $\lambda\gamma$ in the square brackets, we get:

$$q(1-\pi)\left[\frac{[(1-\pi)\lambda+\pi](\overline{x}-q\lambda d)}{(1-\pi)(\overline{x}-q\lambda d)+\pi q(x_l-d)}(1-\gamma-\alpha^*)-\lambda(1-\gamma-\alpha^*)-\lambda\gamma\right].$$

Combining the two terms that include $(1-\gamma-\alpha^*)$ and canceling terms, the slope of the u-type's payoff return function is:

$$q(1-\pi)\left[\frac{\pi(\overline{x}-\lambda q x_l)}{(1-\pi)(\overline{x}-q\lambda d)+\pi q(x_l-d)}(1-\gamma-\alpha^*)-\lambda\gamma\right].$$

This slope is an increasing function of d. To see why, note that *Case 3* of Proposition 1 establishes that $\partial\alpha^*/\partial d<0$, so $(1-\gamma-\alpha^*)$ is an increasing function of d. The denominator of the fraction is obviously a decreasing function of d. Since the slope of the u-type's return is an increasing function of d, the u-type's return is convex. Therefore the u-type's expected return cannot obtain a local maximum in the no-deterrence region. $\square$

Proof of Proposition 3. (Privately-Optimal Liability Rule.) According to Lemma 4, the u-type's return is decreasing in d in *Case 1*, so we know that $d_u^*\leq\overline{d}$. Since the u-type's return is increasing in d in *Case 2* we know that $d_u^*\notin(\underline{d}(\pi),\overline{d})$. Finally, since the u-type's return is convex in d in *Case 3* we know that their return $d_u^*\notin(0,\underline{d}(\pi))$. Therefore $d_u^*\in\{0,\overline{d}\}$.

If $\pi\geq\widehat{\pi}_0$ then $\underline{d}(\pi)=0$ and so the u-type's private optimum is $d_u^*=\overline{d}$. Suppose $\pi<\widehat{\pi}_0$ so $\underline{d}(\pi)>0$. We now consider this case.

Suppose $d=0$ so were are in *Case 3* of Proposition 1 with $\beta^*(0,\pi)=1$. Substituting $d=0$ into the u-type's return in (26) and let α^* be $\alpha^*(0,\pi)$ defined in (16) gives:

$$\Pi_u(0,\pi)=(1-\pi)[(1-\alpha^*)\overline{x}-e].$$

Since $e = k - c$ this becomes:

$$\Pi_u(0, \pi) = (1 - \pi)[\overline{x} - k - (\alpha^* \overline{x} - c)]. \tag{29}$$

Substituting $\beta^* = 1$ and $d = 0$ into the investors' break-even constraint in (2) gives:

$$(1 - \pi)(\alpha^* \overline{x} - c) + \pi q(\alpha^* x_l - c) = 0.$$

$$\iff \alpha^* \overline{x} - c = -\frac{\pi q}{1 - \pi}(\alpha^* x_l - c). \tag{30}$$

Substituting (30) into (29) we rewrite the u-type's return:

$$\begin{aligned} \Pi_u(0, \pi) &= (1 - \pi)(\overline{x} - k) + \pi q(\alpha^* x_l - c) \\ &= (1 - \pi)(\overline{x} - k) + \pi q(\alpha^* x_l - k + e - x_l + x_l) \\ &= (1 - \pi)(\overline{x} - k) + \pi q[-(k - x_l) - ((1 - \alpha^*)x_l - e)] \end{aligned}$$

$$\Pi_u(0, \pi) = (1 - \pi)(\overline{x} - k) - \pi q(k - x_l) - \pi q[(1 - \alpha^*)x_l - e]. \tag{31}$$

This expression is intuitive. The first term is the u-type's aggregate return in a perfect world with no asymmetric information. The u-type does not operate in this perfect world. The second term is the social loss when the l-types participate. The third term are the l-types' rents from participation.

Next, suppose $d = \overline{d}$ defined in (4) so there is full deterrence, $\beta^*(\overline{d}, \pi) = 0$. Using (12), social welfare is:

$$SW(\overline{d}, \pi) = (1 - \pi)(\overline{x} - k - q\lambda\gamma_0\overline{d}) + \pi(1 - q)(x_h - k).$$

Adding and subtracting $(1 - \pi)\gamma q\lambda\overline{d}$, the expression becomes:

$$SW(\overline{d}, \pi) = (1 - \pi)(\overline{x} - k - q\lambda\gamma\overline{d}) + (1 - \pi)(\gamma - \gamma_0)q\lambda\overline{d} + \pi(1 - q)(x_h - k). \tag{32}$$

Recall that social welfare is the sum of the u-type, l-type, h-type, and attorney expected returns. Since there is full deterrence, the l-types get zero. From (28), the attorneys' expected return is $\Pi_a(\overline{d}, \pi) = (1 - \pi)(\gamma - \gamma_0)q\lambda\overline{d}$. The h-type's expected return is $\Pi_h(\overline{d}, \pi) = \pi(1 - q)(x_h - k)$. Therefore (32) can be written

$$SW(\overline{d}, \pi) = (1 - \pi)(\overline{x} - k - q\lambda\gamma\overline{d}) + \Pi_a(\overline{d}, \pi) + \Pi_h(\overline{d}, \pi)$$

and so,

$$\Pi_u(\overline{d}, \pi) = (1 - \pi)(\overline{x} - k) - (1 - \pi)q\gamma\lambda\overline{d}. \tag{33}$$

This expression is intuitive. The first term is the u-type's aggregate return in a perfect world with no litigation. The second term is the expected litigation cost.

We now characterize the threshold $\widehat{\pi}_u \in (0, \widehat{\pi}_0)$. The u-type will prefer $d = 0$ to $d = \overline{d}$ when (31) is larger than (33) or:

$$(1-\pi)(\overline{x}-k) - \pi q(k - x_l) - \pi q[(1-\alpha^*)x_l - e] > (1-\pi)(\overline{x}-k) - (1-\pi)q\gamma\lambda\overline{d}$$

$$\begin{aligned} -\pi q(k - x_l) - \pi q[(1-\alpha^*)x_l - e] &> -(1-\pi)q\gamma\lambda\overline{d} \\ (1-\pi)q\gamma\lambda\overline{d} &> \pi q(k - x_l) + \pi q[(1-\alpha^*)x_l - e]. \end{aligned} \tag{34}$$

Recall that α^* is $\alpha^*(0, \pi)$ defined in (16). This expression is intuitive. The left-hand side is the u-type's loss if $d = \overline{d}$. The loss is the expected payment to the lawyers. The right-hand side is the u-type's loss from $d = 0$. This includes the social loss from the participation of the l-types, $k - x_l$, plus the information rents that accrue to the l-types.

Since $k = c + e$, equation (34) can be rearranged and simplified:

$$\frac{1-\pi}{\pi q} q\gamma\lambda\overline{d} > c - \alpha^*(0, \pi)x_l.$$

Substituting $\alpha^*(0, \pi)$ from (16), we get:

$$\begin{aligned} \frac{1-\pi}{\pi q} q\gamma\lambda\overline{d} &> c - \frac{(1-\pi)cx_l + \pi qcx_l}{(1-\pi)\overline{x} + \pi qx_l} \\ \iff \frac{1-\pi}{\pi q} q\gamma\lambda\overline{d} &> \frac{(1-\pi)c\overline{x} + \pi qcx_l - (1-\pi)cx_l - \pi qcx_l}{(1-\pi)\overline{x} + \pi qx_l} \\ \iff \frac{1-\pi}{\pi q} q\gamma\lambda\overline{d} &> \frac{(1-\pi)(\overline{x} - x_l)c}{(1-\pi)\overline{x} + \pi qx_l} \\ \iff q\gamma\lambda\overline{d} &> \frac{\pi q(\overline{x} - x_l)c}{(1-\pi)\overline{x} + \pi qx_l}. \end{aligned} \tag{35}$$

Using (35) we may easily characterize the threshold $\widehat{\pi}_u \in (0, \widehat{\pi}_0)$, where if $\pi < \widehat{\pi}_u$, the u-type wants $d = 0$, and if $\pi > \widehat{\pi}_u$, the u-type wants $d = \overline{d}$. From (35), $\widehat{\pi}_u$ is implicitly defined by:

$$q\gamma\lambda\overline{d} = \frac{\widehat{\pi}_u q(\overline{x} - x_l)c}{(1-\widehat{\pi}_u)\overline{x} + \widehat{\pi}_u qx_l}.$$

Since $\overline{d} > 0$ defined in (4) does not depend on π, we know that $\widehat{\pi}_u > 0$. Rearranging, the u-type prefers $d = 0$ to $d = \overline{d}$ if and only if $\pi < \widehat{\pi}_u$ where:

$$\frac{1-\widehat{\pi}_u}{\widehat{\pi}_u q} = \frac{(1-x_l/\overline{x})c - q\gamma\lambda\overline{d}x_l/\overline{x}}{q\gamma\lambda\overline{d}}. \tag{36}$$

This is equation (17) in the text. Recall that we proved above that $\widehat{\pi}_u > 0$, so the numerator of (17) is positive. Since the u-type strictly prefers $d = d_u^* = \overline{d}$ to $d = 0$ when $\pi = \widehat{\pi}_0$, we know $\widehat{\pi}_u < \widehat{\pi}_0$ by continuity.

□

Proof of Corollary 1. (Divergence Between Private and Social Incentives.) The right-hand side of (18) is independent of λ, γ and γ_0 because $\alpha^*(0,\pi)$ defined in (16) doesn't depend on these parameters. If $\gamma = \gamma_0$, the left-hand side of (18) is equal to zero so (18) is violated. Therefore the private incentive of the u-type to impose liability is socially excessive, $\widehat{\pi}_u < \widehat{\pi}_s$. If $\gamma > \gamma_0$, the left-hand side of (18) is positive. Lemma 1 implies $\overline{d}$ is weakly increasing in λ. Therefore $\lambda\overline{d}$ on the left-hand side of (18) is also an increasing function of λ. So, as λ increases, the private incentive to impose liability gets weaker relative to the social incentive. When $\lambda = 0$ then (18) is not satisfied. So there exists $\widehat{\lambda} \in (0, 1]$ so that the private incentive to impose liability is stronger than the social incentive for $\lambda \leq \widehat{\lambda}$. □

Proof of Proposition 4. (General Liability Waiver.) We will divide the proof into three cases: (1) when $\pi < \widehat{\pi}_s$ for the social planner or $\pi < \widehat{\pi}_u$ for the u-type, respectively; (2) when $\pi > \widehat{\pi}_0$; and (3) when $\pi \in [\widehat{\pi}_s, \widehat{\pi}_0]$ for the social planner or $\pi \in [\widehat{\pi}_u, \widehat{\pi}_0]$ for the u-type, respectively.

Case 1. Suppose $\pi < \widehat{\pi}_s$ and consider the social planner. From Proposition 2, we know that $SW(0,\pi) > SW(\overline{d},\pi)$. We also know from Lemma 3, that $\frac{\partial SW(d,\pi)}{\partial d} < 0$, whenever $d > 0$. Therefore $SW(0,\pi) > SW(d,\pi) \quad \forall d > 0$. The social planner prefers $d = 0$ to any $d > 0$.

Now, consider the u-type and suppose $\pi < \widehat{\pi}_u$. Similar to the case for the social planner, we know that $\Pi_u(0,\pi) > \Pi_u(\overline{d},\pi)$. We also know, from Lemma 4, that when $d \geq \overline{d}$, $\frac{\partial \Pi_u(d,\pi)}{\partial d} < 0$. Hence, $\forall d \geq \overline{d}$, $\Pi_u(d,\pi) < \Pi_u(0,\pi)$. When $d \in (0,\overline{d})$, (1) the convexity of $\Pi_u(d,\pi)$ with respect to d and (2) $\Pi_u(0,\pi) > \Pi_u(\overline{d},\pi)$ imply that $\Pi_u(0,\pi) > \Pi_u(d,\pi)$ when $d \in (0,\overline{d})$. Therefore, similar to the social planner, the u-type will waive liability when $d > 0$.

Case 2. Suppose $\pi > \widehat{\pi}_0$. We know, from Propositions 2 and 3, that the optimal liability is $d = \overline{d}$ for both the social planner and the u-type. Furthermore, when $d < \overline{d}$, $\frac{\partial SW(d,\pi)}{\partial d} > 0$ and $\frac{\partial \Pi_u(d,\pi)}{\partial d} > 0$. When $d = 0$, the social welfare is given by:

$SW(d=0,\pi) = (1-\pi)(\overline{x}-k)+\pi q(x_h-k)+\pi q\beta^*(0,\pi)(x_l-k)$. From Proposition 1, we know that $\beta^*(0,\pi) = \frac{1-\pi}{\pi q}\cdot\frac{(1-e/x_l)\overline{x}-c}{k-x_l}$. With this expression, we get $\pi q\beta^*(0,\pi)(x_l-k) = (1-\pi)((1-e/x_l)\overline{x}-c$, and social welfare becomes:

$$SW(d=0,\pi) = (1-\pi)(\overline{x}-k)+\pi q(x_h-k)-(1-\pi)((1-e/x_l)\overline{x}-c).$$

Also, when $d=0$, we get $\alpha^*(d=0,\pi) = \frac{x_l-e}{x_l}$, and

$$\Pi_u(d=0,\pi) = (1-\pi)((e/x_l)\overline{x}-e) = (1-\pi)(\overline{x}-k)-(1-\pi)((1-e/x_l)\overline{x}-c).$$

Note that, in both $SW(d=0,\pi)$ and $\Pi_u(d=0,\pi)$ expressions, we have the common term of $(1-\pi)((1-e/x_l)\overline{x}-c)$, reducing the social welfare and the u-type's expected profit equally. This isn't surprising since, in equilibrium, the l-type's expected profit is equal to zero and, with the investors' break-even condition, the expected loss for the u-type will be the same as the expected reduction in social welfare.

When $d \geq \overline{d}$, with $\beta^*(d \geq \overline{d},\pi) = 0$, the social welfare is given by:

$$SW(d \geq \overline{d},\pi) = (1-\pi)(\overline{x}-k)+\pi q(x_h-k)-(1-\pi)q\lambda\gamma_0 d,$$

while the u-type's expected profit is given by:

$$\Pi_u(d \geq \overline{d},\pi) = (1-\pi)(\overline{x}-k)-(1-\pi)q\lambda\gamma d.$$

Note that both expressions are strictly decreasing with respect to d. Hence, when we compare $SW(d=0,\pi)$ with $SW(d \geq \overline{d},\pi)$, and $\Pi_u(d=0,\pi)$ with $\Pi_u(d \geq \overline{d},\pi)$, respectively, $\exists\overline{\delta}_s > \overline{d}$ and $\overline{\delta}_u > \overline{d}$, such that, $(1-\pi)q\lambda\gamma_0\overline{\delta}_s = (1-\pi)q\lambda\gamma\overline{\delta}_u = (1-\pi)((1-e/x_l)\overline{x}-c)$. When we rearrange and solve for $\overline{\delta}_s$ and $\overline{\delta}_u$, we get:

$$\overline{\delta}_u = \frac{(1-e/x_l)\overline{x}-c}{q\lambda\gamma} \leq \frac{(1-e/x_l)\overline{x}-c}{q\lambda\gamma_0} = \overline{\delta}_s,$$

where the inequality is strict whenever $\gamma > \gamma_0$. Note that the expressions are independent of π. When $\pi > \widehat{\pi}_0$, therefore, the social planner will waive liability if and only if $d > \overline{\delta}_s = \frac{(1-e/x_l)\overline{x}-c}{q\lambda\gamma_0}$, and the u-type will waive liability if and only if $d > \overline{\delta}_u = \frac{(1-e/x_l)\overline{x}-c}{q\lambda\gamma}$. This also implies that $\underline{\delta}_s = \underline{\delta}_u = 0$.

Case 3. Suppose $\pi \in [\widehat{\pi}_s, \widehat{\pi}_0]$ and consider, first, the social planner. When $d=0$, from (12), the social welfare is given by: $SW(d=0,\pi) = (1-\pi)(\overline{x}-k)+\pi q(x_h-k)+\pi q(x_l-k)$, and when $d \geq \overline{d}$, the social welfare is: $SW(d \geq \overline{d},\pi) = (1-\pi)(\overline{x}-k-q\lambda\gamma_0 d)+\pi q(x_h-k)$. We also know, from Proposition 2, that $\pi q(k-x_l) \geq (1-\pi)q\lambda\gamma_0\overline{d}$. Given that $SW(d \geq \overline{d},\pi) = (1-\pi)(\overline{x}-k-q\lambda\gamma_0 d)+\pi q(x_h-k)d$ is strictly decreasing with respect to d, this implies that $\exists \overline{\delta}_s \geq \overline{d}$ such that $\pi q(k - x_l) = (1-\pi)q\lambda\gamma_0\overline{\delta}_s$. When we solve for $\overline{\delta}_s(\pi)$, we get:

$$\overline{\delta}_s(\pi) = \frac{\pi}{1-\pi} \cdot \frac{k - x_l}{\lambda\gamma_0}.$$

Note that, as π gets larger, $\overline{\delta}_s$ gets larger. Also, when $\pi = \widehat{\pi}_0$, we know that $\widehat{\pi}_0 q(k - x_l) = (1-\widehat{\pi}_0)q\lambda\gamma_0\overline{d}$. Hence, $\overline{\delta}_s(\widehat{\pi}_0) = \frac{(1-e/x_l)\overline{x}-c}{q\lambda\gamma_0}$.

To establish $\underline{\delta}_s(\pi)$, first, when $d < \underline{d}(\pi)$, we know that $\frac{\partial SW}{\partial d} < 0$ and when $d \geq \underline{d}(\pi)$, $\frac{\partial SW}{\partial d} \geq 0$. Therefore, when $d \in (0, \underline{d}(\pi)]$, we have $SW(d \in (0, \underline{d}(\pi)], \pi) < SW(d = 0, \pi)$. Given that $SW(\overline{d}, \pi) \geq SW(d = 0, \pi)$, this implies that, for any given $\pi \in [\widehat{\pi}_s, \widehat{\pi}_0]$, $\exists \underline{\delta}_s(\pi) \in (\underline{d}(\pi), \overline{d}]$ such that:

$$SW(\underline{\delta}_s, \pi) = (1-\pi)q\lambda\gamma_0\underline{\delta}_s + \pi q\beta^*(\underline{\delta}_s, \pi)(k - x_l + \gamma_0\underline{\delta}_s) = \pi q(k - x_l) = SW(d = 0, \pi).$$

This implicitly defines the function $\underline{\delta}_s(\pi)$. When $\pi = \widehat{\pi}_0$, from Lemma 3, we know that $\underline{d}(\widehat{\pi}_0) = 0$, and $\frac{\partial SW}{\partial d} > 0\ \forall d > 0$. Hence, $\underline{\delta}_s(\widehat{\pi}_0) = 0$. On the other hand, when $\pi = \widehat{\pi}_s$, given that $SW(d = 0, \pi) = SW(d = \overline{d}, \pi)$, we have $\underline{\delta}_s(\widehat{\pi}_0) = \overline{d}$.

Now, consider the u-type and suppose $\pi \in [\widehat{\pi}_u, \widehat{\pi}_0]$. The analysis is fairly similar to that for the social planner. Foremost, when $d = \overline{d}$, the u-type's expected profit is $\Pi_u(d = \overline{d}, \pi) = (1-\pi)(\overline{x} - k) - (1-\pi)q\lambda\gamma\overline{d}$, and when $d = 0$, the u-type's expected profit is $\Pi_u(d = d, \pi) = (1-\pi)(\overline{x} - k) - \pi q((k - x_l) + (1 - \alpha^*(d = 0, \pi))x_l - e)$. We know, from Lemma 4, that $(1-\pi)q\lambda\gamma\overline{d} \leq \pi q((k - x_l) + (1 - \alpha^*(d = 0, \pi))x_l - e)$.

First, suppose that $d \geq \overline{d}$. Given that the u-type's expected profit $(\Pi_u(d \geq \overline{d}, \pi) = (1-\pi)(\overline{x} - k) - (1-\pi)q\lambda\gamma d)$ is strictly decreasing with respect to d and that $(1-\pi)q\lambda\gamma\overline{d} \leq \pi q((k - x_l) + (1 - \alpha^*(d = 0, \pi))x_l - e)$, $\exists \overline{\delta}_u \geq \overline{d}$ such that $(1-\pi)q\lambda\gamma\overline{\delta}_s = \pi q((k - x_l) + (1 - \alpha^*(d = 0, \pi))x_l - e)$. When we rewrite the expression, we get:

$$\overline{\delta}_u(\pi) = \frac{\pi q}{1-\pi} \cdot \frac{(k - x_l) + (1 - \alpha^*(d = 0, \pi))x_l - e}{\lambda\gamma}.$$

When we compare this with $\overline{\delta}_s(\pi) = \frac{\pi q}{1-\pi} \cdot \frac{k - x_l}{\lambda\gamma_0}$, since $(1 - \alpha^*(d = 0, \pi))x_l - e \geq 0$ and $\gamma \geq \gamma_0$, $\overline{\delta}_u(\pi) \lesseqgtr \overline{\delta}_s(\pi)$ when $\pi \in [\widehat{\pi}_u, \widehat{\pi}_0]$. On the other hand, as $\pi \to \widehat{\pi}_0$, we know that $(1 - \alpha^*(d = 0, \pi))x_l - e \to 0$ and $\overline{\delta}_u(\widehat{\pi}_0) \to \frac{\pi q}{1-\pi} \cdot \frac{k - x_l}{\lambda\gamma} < \frac{\pi q}{1-\pi} \cdot \frac{k - x_l}{\lambda\gamma_0} = \overline{\delta}_s(\widehat{\pi}_0)$.

Finally, suppose $d < \overline{d}$. When $d \in (0, \overline{d})$, the u-type's expected profit is given by:

$$\Pi_u(d \in (0, \overline{d}), \pi) = (1-\pi)(\overline{x} - k) - [(1-\pi)q\lambda\gamma d + \pi q((k - x_l) + (1 - \alpha^*(d, \pi))(x_l - d) - e)].$$

First, $\Pi_u(d = \overline{d}, \pi) > \Pi_u(d = 0, \pi)$ implies that $\exists \tilde{d} \in [0, \overline{d}]$ such that $\frac{\partial \Pi_u}{\partial d}|_{\tilde{d}>0}$. This, in turn, implies that $\exists \underline{\delta}_u \in [0, \overline{d}]$ such that $\Pi_u(\underline{\delta}_u, \pi) = \Pi(d = 0, \pi)$. Second, the fact that $\Pi_u(d, \pi)$ is convex with respect to d implies that: (1) $\frac{\partial \Pi_u}{\partial d}|_{\underline{\delta}_u>0}$, since otherwise we cannot have $\underline{\delta}_u$, and (2) $\Pi_u(d > \underline{\delta}_u, \pi) > \Pi_u(\underline{\delta}_u, \pi) \geq \Pi_u(d \leq \underline{\delta}_u, \pi)$. In other words, the u-type will waive liability when $d > \underline{\delta}_u$, but not waive liability when $d \leq \underline{\delta}_u$. $\square$

Appendix B: Supplemental Analyses

In this appendix, we present several analyses to supplement the main findings. In the first subsection, we show how Assumption 3 is sufficient for the investors have a credible lawsuit. Subsection 2 examines the possibility of investors selling their stock before filing lawsuit (and after the firm has raised capital) and show that the main analysis will carry through. Subsection 3 establishes how two-sided litigation costs can be translated into one-sided litigation cost, as we have done in the main model for simplicity. Finally, in subsection 4, we examine the possibility of imposing liability directly on the entrepreneur.

B1 Credibility of Suit

Litigation is credible if the investors' net return from litigation is positive, $(1-\gamma-\alpha^*)d>0$. With positive litigation costs and the fact that, in equilibrium, the investors own a fraction of the firm that pays damages, litigation credibility can become an issue. To ensure that litigation is credible against both the u-type and the l-type, we made the following assumption:

Assumption 3: $\gamma < e/x_l$.

Now we show that this assumption, along with Assumption 1, is sufficient to ensure that the litigation will be credible for the investors in equilibrium, $(1-\gamma-\alpha^*)d>0$ for all α^*.

Foremost, from Proposition 1, we know that, in all three regions (full, partial, and no deterrence), the equilibrium α^* is decreasing with respect to d. Hence, the equilibrium α^* is the highest when $d=0$. Assumption 1 guarantees that $\overline{d}>0$. Thus, when $d=0$, the equilibrium will involve either partial deterrence or no deterrence.

Consider the partial deterrence region in Proposition 1. Since $\alpha^*(0,\pi)=1-\frac{e}{x_l}$, the investors' net return from litigation is $(1-\gamma-\alpha^*)d=(\frac{e}{x_l}-\gamma)d$. Assumption 3 guarantees that this is positive.

Next, consider the no-deterrence region. Setting $\beta^*=1$ and $d=0$ in the investors' break-even condition (2),

$$(1-\pi)(\alpha^*\overline{x}-c)+\pi q(\alpha^* x_l-c)=0.$$

Totally differentiating with respect to π and α^* and rearranging,

$$[-(\alpha^*\overline{x}-c)+q(\alpha^* x_l-c)]\Delta\pi+[(1-\pi)\overline{x}+\pi q x_l]\Delta\alpha^*=0.$$

$$\iff \frac{\Delta\alpha^*}{\Delta\pi} = \frac{(\alpha^*\overline{x} - c) - q(\alpha^* x_l - c)}{(1-\pi)\overline{x} + \pi q x_l} > 0.$$

In other words, when $d = 0$, the equilibrium α^* is increasing with respect to π in the no deterrence region. So, in the no deterrence region, $\alpha^* \leq 1 - e/x_l$. We therefore have $1 - \gamma - \alpha^* > e/x_l - \gamma$, which is greater than zero by Assumption 3.

B2 Stock Sale before Lawsuit

In the main analysis, we have assumed, for convenience, that the outside investors have purchased the stock at the time of equity offering and have not sold their shares by the time of litigation against the firm. When the parameters of the lawsuit are common knowledge and the equity market is sufficiently forward-looking, under the legal regime that allows investors to recover from the firm the loss in value due to unlawful non-disclosure, it is fairly straightforward to incorporate the possibility of stock sale before lawsuit. From the analysis, after the firm has sold the shares to the outside investors at $t = 3$ (IPO), there are two moments when the investor can sell her stock on the market: (1) after the equity sale but before the returns (x) are realized and observed by the investors at $t = 4$; and (2) after they observe the litigation signal (σ) at $t = 4$.

First, if the investors were to sell the stock before the market has observed either x or σ, i.e., when the stock price is relatively high, because the subsequent purchaser will be able to bring suit later (based on Section 11 liability), the purchaser would be willing to pay

$$v = \frac{(1-\pi)[\alpha^*\overline{x} + q\lambda(1-\gamma-\alpha^*)d] + \pi q\beta^*[\alpha^* x_l + (1-\gamma-\alpha^*)d]}{(1-\pi) + \pi q\beta^*} = c$$

for the stock, and this is how much the stock is worth to the seller. Note that the valuation is done with respect to the block α^* that is being traded on the market. When the initial investor sells the stock, since the stock price has not changed from the IPO price, they will not have a claim against the firm (since they have not suffered any harm), while the purchaser will have a claim against the firm when the stock price drops subsequently.

Second, after observing x_l, suppose the market has observed the realized litigation signal (σ). If $\sigma = 0$, since the investors do not have a claim against the firm (i.e., there was no indication that there was a material omission), the stock will be worth (and will trade at) $\alpha^* x_l$. If $\sigma = 1$, on the other hand, the investors (market) are aware that there was a material omission. Hence, the purchaser will not have a claim against the firm and the stock will also be worth $\alpha^* x_l$ to the purchaser. At the same time, the seller will still have a claim since the seller was not aware of the material omission at the time of purchase and the damages will be based on the drop in stock price. For instance, if the seller bought the stock at the IPO, the drop in price will be equal to:

$$\frac{(1-\pi)[\alpha^*\overline{x} + q\lambda(1-\gamma-\alpha^*)d] + \pi q\beta^*[\alpha^* x_l + (1-\gamma-\alpha^*)d]}{(1-\pi)+\pi q\beta^*} - \alpha^* x_l.$$

In fact, the seller's return is bifurcated into two: one, based on the proceeds from the sale (at $\alpha^* x_l$), and the other, a litigation claim (d) against the firm.

B3 Two-Sided Litigation Costs: A Transformation.

In the main text, we simplified the analysis by assuming that only the investor-plaintiffs bear litigation costs. Suppose that the firm-defendant must bear litigation costs, too. Let d be the court-awarded damages, $\gamma_d d$ the firm-defendant's litigation costs; $\gamma_p d$ the investor-plaintiffs' litigation costs; $\gamma_p d$ and $\gamma_d d$ the lawyers' opportunity costs. Let's define new variables:

$$\widehat{d} = d(1+\gamma_d), \quad \widehat{\gamma} = \frac{\gamma_p + \gamma_d}{1+\gamma_d}, \quad and \quad \widehat{\gamma}_0 = \frac{\gamma_{0p} + \gamma_{0d}}{1+\gamma_d} \tag{37}$$

Our model with litigation costs for the plaintiff and firm is isomorphic to a model where the firm's litigation cost is 0, the plaintiffs' litigation cost is $\widehat{\gamma}\widehat{d}$, and the lawyers' opportunity cost is $\widehat{\gamma}_0\widehat{d}$. The following analysis demonstrates the equivalence.[63]

With litigation costs, the l-type's payoff is:

$$(1-\alpha)(x_l - (1+\gamma_d)d) - e.$$

Using the formula for $\widehat{d}$ from (37), the l-type's payoff is:

$$(1-\alpha)(x_l - \widehat{d}) - e.$$

This is aligned with equation (1) in the main text. Now consider the u-type's payoff is:

$$(1-\alpha)(\overline{x} - q\lambda(1+\gamma_d)d) - e$$

Using the formula for $\widehat{d}$ from (37), the u-type's payoff is is:

$$(1-\alpha)(\overline{x} - q\lambda\widehat{d}) - e$$

[63] This is ignoring the credibility constraint for the plaintiffs.

This is the same as in the main text. Notice that with the transformation, it appears "as if" the firm has no litigation costs. Finally, consider the investors. Suppose $x = x_l$ and there is a lawsuit. The investors' payoff with the old notation:

$$\alpha x_l - c + (1 - \gamma_p - \alpha(1 + \gamma_d))d.$$

Rearranging this expression, with some algebra:

$$= \alpha x_l - c + \left(1 - \frac{\gamma_p + \gamma_d}{1 + \gamma_d} - \alpha\right) d(1 + \gamma_d).$$

Using the formulas for $\widehat{d}$ and $\widehat{\gamma}$ from above, the investors' payoff if $x = x_l$ and there is a lawsuit is:

$$\alpha x_l - c + (1 - \widehat{\gamma} - \alpha)\,\widehat{d}.$$

Now consider social welfare. Using the old notation, social welfare is:

$$(1 - \pi)(\overline{x} - k - q\lambda(\gamma_{0p} + \gamma_{0d})d) + \pi(1 - q)(x_h - k) + \pi q\beta(x_l - k - (\gamma_{0p} + \gamma_{0d})d)$$

Using the formulas for $\widehat{d}$ and $\widehat{\gamma}_0$ above,

$$(\gamma_{0p} + \gamma_{0d})d = \left(\frac{\gamma_{0p} + \gamma_{0d}}{1 + \gamma_d}\right)(1 + \gamma_d)d = \widehat{\gamma}_0\widehat{d}.$$

The social welfare function is:

$$(1 - \pi)(\overline{x} - k - q\lambda\widehat{\gamma}_0\widehat{d}) + \pi(1 - q)(x_h - k) + \pi q\beta(x_l - k - \widehat{\gamma}_0\widehat{d})$$

This is aligned with (12) in the main text. This proves that a model with proportional litigation costs on both sides is isomorphic to a model with proportional litigation costs for the plaintiff only.

B4 Entrepreneur Liability

The paper assumed that the firm was held liable for the entrepreneur's non-disclosure of material information. Suppose instead that E may be held *personally* liable (and the firm is not held liable) for withholding evidence about x. (We are also assuming that E is not subject to any wealth constraint and has the capacity to pay.) The outside investors, after observing the realized x, can bring suit against the entrepreneur to recover damages d. Since the damage award is paid by the entrepreneur instead of the firm, the value of the firm's equity is unaffected by the lawsuit.

Not surprisingly, holding the entrepreneur personally liable creates stronger deterrence. To see why, suppose the l-type is just indifferent between participating and not and the outside investors break even in expectation. The l-type is indifferent if

$$(1-\alpha^*)x_l - e - d = 0. \tag{38}$$

Comparing this condition to (1) reveals an important difference. When the entrepreneur is personally liable, he bears one hundred percent of the damage award d rather than bearing only their proportional share via the reduction in firm value, $(1-\alpha^*)d$. The outside investors' break-even condition in (2) becomes:

$$(1-\pi)[\alpha^*\overline{x} - c + q\lambda(1-\gamma)d] + \pi q\beta^*[\alpha^* x_l - c + (1-\gamma)d] = 0. \tag{39}$$

Compared with (2), the outside investors do not suffer from the reduction in share value ($\alpha^* d$) when E pays the damages.

As in the general model, if d is above a threshold, the l-type entrepreneur is fully deterred: $\beta^*_{EL} = 0$. With full deterrence, from (39), we get $\alpha^* = \frac{c-q\lambda(1-\gamma)d}{\overline{x}}$. Equation (38) implies that the l-type is just indifferent between participating and not when $d > \overline{d}_{EL}(e)$ where

$$\overline{d}_{EL} = \left(1 - \frac{c-q\lambda(1-\gamma)d}{\overline{x}}\right)x_l - e. \tag{40}$$

When we compare (40) with (4), it is straightforward (though with some algebra) to show that $\overline{d}_{EL} < \overline{d}$. That is, the l-type is fully deterred for a broader range of parameter values than before.

Similarly, if the damages d are at the threshold where the l-type is (just) undeterred, $\beta^*_{EL} = 1$, then the equilibrium equity stake becomes

$$\alpha^*(\underline{d}, \pi) = \overline{\alpha}_{EL}(\underline{d}) + r_{EL}(\underline{d}, \pi), \tag{41}$$

where $\overline{\alpha}_{EL}(\underline{d}) = \frac{c-q\lambda(1-\gamma)\underline{d}}{\overline{x}}$ and $r_{EL}(\underline{d}, \pi) = \frac{\pi q}{1-\pi} \cdot \frac{k+\gamma\underline{d}-x_l}{\overline{x}}$. Using (38), we get:

$$\underline{d}_{EL}(\pi) = (1-\overline{\alpha}_{EL}(\underline{d}))x_l - e. \tag{42}$$

Comparing this to equation (8) will establish (with some algebra) that $\underline{d}_{EL}(\pi) < \underline{d}(\pi)$, so the l-type is undeterred for a smaller range of parameter values than before. See Figure B2.

For a given d, with no deterrence ($\beta^*_{EL} = 1$), the equilibrium fraction of the firm

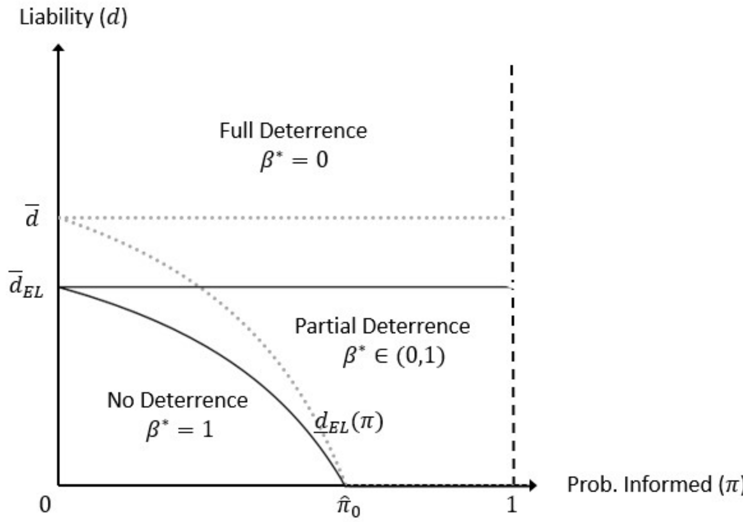

Figure 3: Entrepreneur Liability

sold to the investors is given by:

$$\alpha^*_{EL}(d,\pi) = \frac{(1-\pi)(c - q\lambda(1-\gamma)d) + \pi q(c-(1-\gamma)d)}{(1-\pi)\overline{x} + \pi q x_l}.$$

When we compare this expression with (11), when $d = 0$, $\alpha^*_{EL}(0,\pi) = \alpha^*(0,\pi)$. Also, with partial deterrence, the equilibrium participation rate by the l-type is given by:

$$\beta^*_{EL}(d,\pi) = \frac{1-\pi}{\pi q} \cdot \frac{(1-\frac{d+e}{x_l})\overline{x} - (c - q\lambda(1-\gamma)d)}{k+\gamma d - x_l} \in [0,1].$$

When we compare this expression with (10), we see that $\beta^*_{EL}(d,\pi) \leq \beta^*(d,\pi)$. That is, conditional on partial deterrence and on d, holding the entrepreneur personally liable improves social welfare. The improvement in social welfare stems not only from a lower participation by the l-type but also a lower rate of litigation in equilibrium.

The fact that $\overline{d}_{EL} < \overline{d}$ implies that the social planner's and the u-type's preference over liability will differ with entrepreneur personal liability. Foremost, with $\overline{d}_{EL} < \overline{d}$, when the l-type is fully deterred with $d = \overline{d}_{EL}$, compared with the case with firm liability, the cost of legal representation and the size of lawyers' opportunity cost are lower: $(1-\pi)q\lambda\gamma\overline{d} > (1-\pi)q\lambda\gamma\overline{d}_{EL}$ and $(1-\pi)q\lambda\gamma_0\overline{d} > (1-\pi)q\lambda\gamma_0\overline{d}_{EL}$, respectively. This implies that, for both the social planner and the u-type, the optimal liability regime is more likely to involve full liability ($d = \overline{d}_{EL}$) than no liability. Finally, with full liability, the amount of rent captured by the lawyers is smaller compared to the case of firm liability:

$$(1-\pi)q\lambda(\gamma-\gamma_0)\overline{d} > (1-\pi)q\lambda(\gamma-\gamma_0)\overline{d}_{EL}.$$

Because the amount of rent captured by the l-type with no liability ($\pi q[(1-\alpha^*(0,\pi))x_l - e]$) is the same in both cases, the u-type is less likely, compared to the social planner, to waive liability. Therefore, with entrepreneur personal liability, there could be too much litigation (and too little waiver), in equilibrium.

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