An economic analysis of corporate directors' fiduciary duties

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I present a principal-agent model where the shareholders (principal) can take legal action against the director (agent). The court's decision provides a verifiable but costly and imperfect signal on the director's fulfilment of his fiduciary duties. The director's remuneration can be made contingent not only on performance but also upon the court's decision. I show that when damage awards are high enough, the widespread use of liability insurance and limited-liability provisions that is observed in the United States is optimal because it allows for a more efficient litigation strategy to be ex post *rational for the shareholders.*

I have never not been entangled in a lawsuit; I have had at least one pending against me as a director since I first began serving. It is absurd. I have never had a judgement against me, but you know, you have to keep looking over your shoulder and wondering what's going to sneak up next.

Anonymous Director[1]

1. Introduction

■ The debate on the effectiveness of boards of directors as a corporate governance mechanism has been centered on directors' independence, and little attention has been paid to the incentives that directors are given.[2] As Bhagat and Black (1998) point out, this could explain why empirical results have come out mixed, for incentives are likely to be more important determinants of board effectiveness than mere independence.

Leaving aside reputational issues, legal liability sanctions imposed for breaches of fiduciary duties and performance-sensitive remuneration such as bonuses or stock options can serve as powerful incentives for both outside and inside directors. However, the suitability of existing legal liability rules and the adequacy of performance-sensitive compensation for directors are questions open to debate, and there are striking differences in the way these incentive mechanisms are used in the United States and in continental Europe.

Directors are held personally liable for failure to comply with their fiduciary duties and may have to pay both compensatory and punitive damages to the shareholders. The liability rules fix

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[1] Extracted from a selection of interviews with over 100 directors conducted by Lorsch and MacIver (1989), this quote (p. 81) reflects the interviewed directors' prevalent view of legal liability.

[2] For a review of the empirical literature on boards of directors, see Kose and Senbet (1998).

aspects of procedure, burden of proof, and damages. In the United States, suits for breaches of fiduciary duties are frequent, and some claim that current legal rules on shareholder derivative action favor the filing of marginal cases and ask for a reform to protect directors from frivolous litigation (Loewenstein, 1998; Romano, 1991b).[3] In continental Europe, the situation is very different. Directors are sued in cases of fraud, but suits for breaches of fiduciary duties are very rare, and cases in which the defendant is found culpable are even rarer.

However, the greater frequency of litigation in the United States seems to be compensated by a widespread use by American firms of liability insurance, limited-liability provisions, and caps on damages. According to a survey conducted by Louis Harris and Associates (1995), over 90% of Fortune 1000 company directors are covered by a directors' and officers' liability policy (D&O). Under a typical D&O liability policy, the insurance company will pay on behalf of the director the loss resulting from claims against him for breaches of fiduciary duties that do not constitute fraudulent acts. Many firms have also adopted limited-liability provisions (LLPs) in their statutes.[4] These statutory provisions effectively eliminate the directors' personal liability for monetary damages to the shareholders. Finally, many states allow the companies to place caps on the amount of damages that their directors should pay for monetary damages arising from breach of fiduciary duty.

Some claim that these are examples of how U.S. directors have been successful in isolating themselves from court discipline (Bishop, 1981). In continental Europe, changes in the statutes limiting directors' liability are forbidden and D&O insurance is very rarely used. D&O insurance is forbidden in Germany, where the legislature considers that its use would both reduce the levels of diligence of directors and increase the compensatory demands of plaintiffs. Thus, according to this argument, social welfare could be improved by forbidding the adoption of protective measures.

However, there is some empirical evidence indicating that the adoption of D&O liability insurance and LLPs creates value for the shareholders (Bhagat, Brickley, and Coles, 1987; Brook and Rao, 1994). These authors argue that given the high level of damage awards, fear of personal liability will reduce the number of able risk-averse individuals willing to serve as directors. Protective measures can solve this problem, and such alternative incentives as performance-sensitive compensation can discipline directors without imposing unfair risks on them. So, if the adoption of costly protective measures is the response to inefficiently high damage awards, social welfare could be improved by reducing those awards. But if this is the case, the obvious question to ask is why the damage awards are so high in the first place.

The model presented here explains the reasons for these differences in the frequency of derivative litigation and the use of protective measures across time and different legal systems. I study how the characteristics of the legal system and the specific regulation of fiduciary duties affect the contractual relationship between shareholders and directors. Specifically, I consider (i) how changes in the level of damage awards, legal fees, the probability of legal errors, and the availability of liability insurance alter both the directors' incentives to fulfill their fiduciary duties and the shareholders' incentives to litigate, and (ii) how this in turn alters the optimal fiduciary contract that maximizes firm value.

The remainder of the article is organized as follows. Section 2 briefly summarizes the related literature. The model and the results are presented in Sections 3 and 4, respectively. Section 5 discusses some extensions of the basic model. Section 6 concludes. All proofs are found in the Appendix.

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[3] A 1995 survey conducted in the United States of 500 outside directors by Louis Harris & Associates found out that 40% of them had been sued in their capacity as an outside director. A 1996 survey conducted of 1,000 firms by Wyatt Co. revealed that 30% of them had experienced one or more claims against their directors, with shareholders being the most frequent class of claimant.

[4] After the majority of U.S. jurisdictions adopted statutes that allowed LLPs in 1996, more than 70% of large publicly held corporations amended their articles of incorporation to include them.

2. Related literature

■ The model presented here builds on previous work that has adapted the principal-agent framework to include the possibility of litigation (see, for instance, Simon, 1981, and P'ng, 1987).

Shavell (1982) was the first to analyze the effects of different liability rules and the availability of insurance in a model in which the courts perfectly enforce an optimal prevention standard and both the victim (the principal) and the injurer (the agent) may purchase insurance to offset the effects of the penalties. He concludes that both negligence and strict liability rules create incentives to take care but that they differ with respect to the allocation of risks. When the parties can buy insurance, these differences are mitigated but the incentives for care are altered.

My model is closer to Sarath (1991) in that the agent's compensation and the principal's litigation strategy are chosen by the principal so as to implement an action at minimal cost and in that the litigation process is uncertain. Sarath uses this framework to study whether unrestricted access to insurance by the agent may be optimal. He shows that when the agent can buy insurance, the optimal level of penalties has to increase to maintain the incentives for exerting care. But this increase in penalties in turn induces overlitigation, resulting in higher costs for the principal. He concludes that when litigation is costly, there may be reasons for limiting insurance and simultaneously lowering the penalties imposed on the agent.

The model presented here differs from Sarath's in that the uncertainty of the legal system is due not to a stochastic negligence standard but to the imperfect observation of the agent's level of care. This raises a moral hazard problem between the agent and the insurer because the insurer cannot observe *ex post* the agent's level of care. This problem is solved by having the uninformed principal buy insurance for the agent. Therefore, access to insurance by the agent is not considered.

Another important difference is the assumption of risk neutrality. In both Shavell (1982) and Sarath (1991), the only reason why the agent may buy insurance is to reduce his exposure to risk. In my model, the principal may buy insurance for the agent for the same reason, but more interestingly, he may also buy insurance to alter his own incentives to litigate. For simplicity and to focus attention on this second reason, I shall assume that the director is risk neutral.

3. The model

■ **Agents and payoffs.** Consider a publicly held firm in which ownership is dispersed among many small risk-neutral shareholders. Each one of them invests a small part of his wealth in the firm. The funds are used to finance a risky project and to contract a director to supervise the running of the firm on their behalf.[5] The market discount rate is normalized to zero.

The director is risk neutral and his reservation level of utility equals his initial wealth w. The director has the choice between exerting a high level of care, which has a cost c_H for the director, or a low level of care at no cost.

The project has a cost C, and its return can be one or zero. Let p_i denote the probability of obtaining a low return when the level of care is $i = H, L$. A high level of care results in a low probability of obtaining a low return, so $p_H < p_L$. The return from the project is observable and verifiable.

Throughout the article it is assumed that the cost of exerting a high level of care is lower than the expected increase in the shareholders' wealth, that is,

$$c_H < p_L - p_H. \tag{1}$$

This means that a high level of care is optimal. Furthermore, it is assumed that the expected net

[5] In general, this model does not apply to executives because they are employees of the firm and employees are not subject to fiduciary duties. However, it applies to the executives who are also members of the board and, in particular, to the CEO.

return when no care is exerted is negative, so

$$(1 - p_L) < C. \tag{2}$$

Therefore, the shareholders will not invest unless a high level of care is chosen with a sufficiently high probability.

□ **The legal system.** After the return from the project is observed, the shareholders can take legal action against the director. In doing so, the shareholders can obtain an imperfect and costly (but verifiable) signal about the director's level of care.

Initiating legal proceedings against the director has a cost K for the shareholders in litigation expenses and attorneys fees.[6] For simplicity I assume that the sued director does not pay legal fees (alternatively, his legal fees are paid for by the shareholders).[7]

The court applies a negligence rule. This means that for a breach of the duty of care to exist, there must be damage to the corporation caused by a negligent action of the director. Therefore, the shareholders can file a suit only when the project yields a low return. The court then observes a signal on the level of care to determine whether the director was negligent. The signal can be high or low. Let q_i denote the probability of obtaining a low signal when the level of care is $i = H, L$. A high level of care results in a low probability of obtaining a low signal, so $q_H \leq q_L$. Therefore, a high (low) signal indicates a high probability that the director did (did not) exert a high level of care and will be interpreted as evidence of innocence (culpability).[8]

The award for damages D is fixed and known by both the shareholders and the director. However, the director is protected by limited liability. In this setting this means that he will never pay more than his initial wealth w.

There are three different mechanisms by which the shareholders can shift the legal risk that the director faces. First, the shareholders can buy a liability insurance policy that covers the director. If the director has to pay a penalty D to the shareholders and he is insured, he will pay the fraction $\min\{w, \beta D\}$, with $\beta < 1$, and the insurance company will pay $(1 - \beta)D$. Second, the shareholders can amend the articles of incorporation to allow for limited-liability provisions (LLPs) that eliminate liability for breaches of the duty of care. This means that the shareholders commit not to initiate legal proceedings. Third, the shareholders can establish a cap on the amount of damages that the director should pay if found culpable. Under this mechanism, if the director has to pay a penalty D, the shareholders will only receive the fraction $\min\{w, \beta D\}$.

Let I represent an indicator function that takes the value one if the director is insured and zero otherwise. When $I = 1$, β is the coinsurance rate, and when $I = 0$, β is the cap on the damage award. When the court finds the director culpable he pays $\min\{w, \beta D\}$ and the shareholders receive $\min\{w, \beta D\} + I(1 - \beta)D$. Table 1 summarizes the different mechanisms.

□ **The contract.** The remuneration of the director can be made contingent on the result of the project and/or on the court's decision. Consequently, I denote the incentive scheme offered by the shareholders to the director by a vector $z \equiv (s, \alpha, I, \beta)$, where s is the base salary, α is a share in the returns of the project, and I and β are the protective measures agreed upon. The base salary and the share in returns must be nonnegative in order to comply with limited-liability rules.

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[6] At a minimum, K includes the legal fees. These costs seem to be substantial. The average legal fees for duty-of-care cases exceeded $400,000 in 1989 (Romano, 1991a). But K can also include other costs, such as the cost of disclosing private information to the court and the public.

[7] The qualitative results are unchanged if we assume that the shareholders recover K when the director is found culpable.

[8] This setup incorporates two interesting limit cases. If $q_L = q_H = 1$, we have a strict liability rule. If $q_L = (1 - q_H) = 1$, the court has perfect information about the director's level of care. The results presented below are valid for both cases.

TABLE 1 **Possible Values of I and β**

	I	β
No protective measures	0	1
D&O liability insurance	1	$\beta \in [0, 1)$
LLPs	0	0
Cap on damages	0	$\beta \in [0, 1)$

□ **The liability insurance market.** The shareholders can buy a "tailor-made" liability insurance policy from an insurance company that operates in a competitive insurance market. This has two important implications. First, a competitive market ensures that the premium charged by the insurance company will be actuarially fair, i.e., the premium will be fixed so that the insurance company will make zero profit on average. Second, the insurance company fixes the premium for each corporation on an individual basis after observing the compensation scheme z. This assumption tries to capture the actual contracting process that takes place between the insurer and the firm. When offering D&O liability insurance, insurance companies do not behave like life insurers, who set the same fee for large classes of potential customers. They offer tailor-made insurance contracts that take into account the particular circumstances of the operation to be insured. Insurance companies make extensive enquiries into the characteristics of the firm and its directors[9] and include in the contract a clause that allows for early termination in case those characteristics change.

□ **Timing.** The timing of the game is summarized in the following time line (see Table 2). At $t = 1$, the shareholders offer a contract $z \equiv (s, \alpha, I, \beta)$ to the director such that he decides to accept it. If the contract includes liability insurance, the insurance is paid for at $t = 1$ after the contract is accepted by the director. At $t = 2$, the director chooses the level of care. The probability that the director chooses a high level of care will be denoted by $\mu \in [0, 1]$. At $t = 3$, the return of the project is realized and the shareholders decide whether to initiate legal proceedings at a cost K. The probability that the shareholders proceed against the director will be denoted by $\lambda \in [0, 1]$. Finally, at $t = 4$, the court observes the signal on the level of care and gives its verdict. Payoffs are then realized. The informational structure is such that except for the director's level of care, all other variables are observable.

□ **Equilibrium concept and strategy for the analysis.** Formally, this is a three-stage dynamic game of complete but imperfect information. We look for a subgame-perfect equilibrium of the game such that the vector (z, μ, λ) maximizes the shareholders' profits subject to the director accepting the contract and given the restrictions imposed by the legal system on the values of I and β.

To characterize the equilibrium of the game I proceed backward. First, I look at the litigation stage to characterize the shareholders' choice on whether to sue. Second, I study how the contract affects the director's choice of his level of care. Third, I find the optimal contract by maximizing the value of the firm to its shareholders.[10]

[9] In particular, insurance companies require the latest 10K form filed by the applicant company with the Securities and Exchange Commission. Form 10K, in its items 10 and 11, requires the registrant to "Describe any standard arrangements, stating amounts, pursuant to which directors of the registrant are compensated for any services provided as a director, including any additional amounts payable for committee participation or special assignments," according to items 401 and 405 of SEC regulation S-K.

[10] The normative perspective I adopt is the perspective of maximizing *ex ante* firm value. This perspective is consistent with the normative orientation of fiduciary duties as an obligation to act in the best interest of the shareholders (Easterbrook and Fishel, 1991).

TABLE 2 Sequence of Events

$t = 1$	Shareholders offer contract (z)
$t = 2$	Director chooses level of care (μ)
$t = 3$	Return of project realized (1 or 0)
	Shareholders decide whether to sue (λ)
$t = 4$	Court observes signal (high or low) and gives its verdict
	Payoffs realized

4. Optimal protective measures

■ In this section I characterize the equilibrium of the game proceeding backward. Consider first the court's decision once the shareholders have decided to sue the director after having observed a low return. The model assumes that the court's decision is based on "hard" evidence (the realization of the court's signal on the level of care conditional on the return being low) and not on the prior μ. This is because the prior μ must rely on "soft" information about the firm and the director (in particular on p_L, p_H, and c_H). The court is unlikely to have access to this type of information. Moreover, even if the information is available, it is nonverifiable, which makes its use by a court of justice undesirable. Therefore, after observing its signal the court declares the director culpable when the signal is low. At this stage the probability that a director who exerted a high (low) level of care c_H (c_L) is found culpable is q_H (q_L).

Now consider the decisions of the shareholders and the director once they have entered the contract. At this stage, z has been fixed and the insurance policy has been paid for. The payoff functions of the shareholders and the director are

$$\begin{aligned} U_s(z, \mu, \lambda) = {} & (1 - \alpha)[\mu(1 - p_H) + (1 - \mu)(1 - p_L)] - s - C \\ & + \lambda[\mu p_H q_H + (1 - \mu)p_L q_L] \min\{w, \beta D\} - \lambda[\mu p_H + (1 - \mu)p_L] K \\ & + I\lambda[\mu p_H q_H + (1 - \mu)p_L q_L](1 - \beta)D \\ & - I\lambda^*(z)\left[\mu^*(z)p_H q_H + (1 - \mu^*(z))p_L q_L\right](1 - \beta)D \end{aligned} \tag{3}$$

and

$$\begin{aligned} U_d(z, \mu, \lambda) = {} & \alpha[\mu(1 - p_H) + (1 - \mu)(1 - p_L)] + s - \mu c_H + w \\ & - \lambda[\mu p_H q_H + (1 - \mu)p_L q_L] \min\{w, \beta D\}. \end{aligned} \tag{4}$$

The first term in the shareholders' payoff function represents the fraction of the expected return of the project that goes to the shareholders. The second and third terms represent the fixed salary paid to the director and the cost of the project. The fourth term is the share of the expected damage award that the director will pay if the shareholders sue him after having observed a low return. Given that the director chooses the high level of care with probability μ, this expected award is calculated as the probability that the project fails $\times$ the probability that shareholders sue $\times$ the probability that the court finds the director culpable $\times$ the amount that the director pays. The fifth term is the expected litigation cost. Given that the director chooses the high level of care with probability μ, this cost is calculated as the probability that the project fails $\times$ the probability that shareholders sue.

The last two terms in the shareholders' payoff function represent respectively the benefits and the costs of the insurance policy. The sixth term represents the share of the expected damage award that the insurance company will pay if the shareholders go to court, which is equal to the probability that litigation occurs and the director is found culpable $\times$ the percentage of the damage award to be paid by the insurance company. Finally, the last term is the premium that the shareholders pay for the insurance policy. Since we are assuming a competitive insurance market,

the price that the shareholders pay for the liability policy equals the amount that the insurance company expects to pay. Moreover, given that insurance is bought right after the terms of contract z are fixed, the insurance company will compute this expected payment on the basis of $\mu^*(z)$ and $\lambda^*(z)$, i.e., the predictable optimal choices of the director and the shareholders for contract z. Setting the premium equal to this expected payment guarantees that the insurance company's break-even constraint holds *ex ante* in expected terms.

With respect to the director's payoff function, the first and second terms are equivalent to the first and second terms in the shareholders' payoff function. The third term is the disutility of care, and the fourth term is the director's initial wealth. Finally, the fifth term corresponds to the fourth term in the shareholders' payoff function.

I now derive the equilibrium strategies of the director and the shareholders in the game induced by a contract $z \equiv (s, \alpha, I, \beta)$.

□ **The role of protective measures in inducing litigation.** Consider first the third stage. Upon observing a low return the shareholders update the probability that the director exercised a high level of care to

$$\mu' = \frac{\mu p_H}{\mu p_H + (1 - \mu) p_L}.$$

Then they decide whether to sue the director. The shareholders' strategy will be determined by their *ex post* incentives to litigate. In particular, they will compare the cost of initiating legal proceedings, K, with the expected damage award, so they will sue with probability $\lambda > 0$ only if

$$\left[\mu' q_H + (1 - \mu') q_L\right]\left[\min\{w, \beta D\} + I(1 - \beta)D\right] \geq K.$$

We can characterize the litigation strategy of the shareholders as the best response to the director's level of care. Let $\overline{\mu}$ represent the value of μ that leaves the shareholders indifferent between their two possible strategies:

$$\overline{\mu} = \frac{p_L\left(q_L\left[\min\{w, \beta D\} + I(1 - \beta)D\right] - K\right)}{(p_L q_L - p_H q_H)\left[\min\{w, \beta D\} + I(1 - \beta)D\right] - (p_L - p_H)K}. \tag{5}$$

For any level of care μ the shareholders' best response depends on the protective measures included in the fiduciary contract I and β and on the characteristics of the firm p_L, p_H, the director's wealth w, and the legal system D, q_L, q_H, K. Clearly, if the damage award is low compared to the costs of litigation or the legal system is inefficient at punishing culpable defendants, the expected payoff from litigating against a culpable defendant is so low that it does not cover litigation costs ($q_L D < K$) and litigation is not possible for any firm in the economy. In what follows, in order to concentrate on cases where litigation is feasible, I limit the inefficiency of the legal system by assuming that $q_L D \geq K$.

The only choice variables of the shareholders that can alter their incentives to litigate are I and β. Therefore, the litigation strategy of the shareholders depends on whether protective measures are allowed.

Lemma 1. When protective measures are not allowed, ($I = 0, \beta = 1$), for a given level of care μ the shareholders' best response is such that

(i) if $q_L w < K$, the shareholders never litigate;

(ii) if $q_H \min\{w, D\} \leq K \leq q_L w$, the shareholders will (will not) litigate if μ is lower (higher) than $\overline{\mu}$, and they will play a mixed strategy, $\lambda \in [0, 1]$, if $\mu = \overline{\mu}$; and

(iii) if $K < q_H \min\{w, D\}$, the shareholders always litigate.

When protective measures are allowed, for a given level of care μ, the shareholders' best response is such that they will (will not) litigate if μ is lower (higher) than $\overline{\mu}$, and they will play a mixed strategy, $\lambda \in [0, 1]$, if $\mu = \overline{\mu}$.

When legal uncertainty is high (q_H is close to q_L) and protective measures are not allowed, we may observe very high or very low litigation levels independent of the level of care exerted by the director. If $q_L w < K$, the director's wealth is so low that the shareholders' expected payoff from litigating is always negative. Therefore the only possible equilibria are those with no litigation. If $K < q_H \min\{w, D\}$, the expected damage award is so high relative to legal costs that the expected payoff from litigating against a nonculpable director is strictly positive, so that the only possible equilibria are those in which the shareholders always litigate. If $q_H \min\{w, D\} \leq K \leq q_L w$, the litigation level will depend on the level of care exerted by the director.

The introduction of protective measures alters the shareholders' *ex post* incentives to litigate by increasing or decreasing the effective damage award they will receive from the director and the insurance company. So by introducing protective measures, we expand the set of possible Nash equilibria. Equilibria with a positive probability of litigation are possible even when the director's wealth w is too low to cover litigation expenses K, provided that liability insurance is available. Additionally, equilibria where the shareholders always litigate can be avoided by introducing a limited-liability provision or a cap on damages that reduces the expected penalty.

□ **The role of protective measures and contingent compensation in inducing the director to exert care.** Now we move to the second stage. Since the return of the project when no care is exerted ($\mu = 0$) is negative, I shall restrict attention to the cases where $\mu \in (0, 1]$. This requires that the director's utility when he exerts a high level of care be at least as high as his utility when he does not:

$$\alpha(1 - p_H) - c_H - \lambda p_H q_H \min\{w, \beta D\} \geq \alpha(1 - p_L) - \lambda p_L q_L \min\{w, \beta D\}.$$

We can characterize the director's choice of the level of care as the best response to the shareholders' litigation strategy. Let $\bar{\lambda}$ represent the value of λ that leaves the director indifferent between his two possible strategies:

$$\bar{\lambda} = \frac{c_H - \alpha(p_L - p_H)}{(p_L q_L - p_H q_H)\min\{w, \beta D\}}. \tag{6}$$

For any level of litigation λ, the director's best response depends on the characteristics of the firm c_H, p_L, p_H, on the director's wealth w, on the legal system D, q_L, q_H, and on the contract provisions about both the share in returns the project α and the protective measures β chosen by the shareholders.

As α and β (the choice variables of the shareholders) increase, $\bar{\lambda}$ decreases. If $\lambda > \bar{\lambda}$, the director will always choose a high level of care, $\mu = 1$. If $\lambda = \bar{\lambda}$, the director may play a mixed strategy, $\mu \in (0, 1]$.

The shareholders can always chose α so as to induce a high level of care independently of their litigation strategy, but if α is low, a strictly positive level of litigation may be necessary to induce a high level of care. Therefore, contingent compensation and the threat of litigation are alternative ways to induce the director to exert a high level of care. The choice of the protective measures to be included in this contract alters this tradeoff by altering the cost for the director in case of litigation and the shareholders' incentives to litigate.

We can now define $N(z)$ as the set of Nash equilibria of the subgame that comprises the second and third stages of the game. The set $N(z)$ may have three different types of equilibria: the equilibria where both players are indifferent about their actions $(\bar{\mu}, \bar{\lambda})$, the equilibria where both players have a strict preference for one of their actions $(1 > \bar{\mu}, 0 > \bar{\lambda})$ and $(1 < \bar{\mu}, 1 > \bar{\lambda})$, and the equilibria where one of the players has a strict preference while the other is indifferent $(1 = \bar{\mu}, \lambda > \bar{\lambda})$, $(\mu > \bar{\mu}, 0 = \bar{\lambda})$, and $(\mu < \bar{\mu}, 1 = \bar{\lambda})$.

□ **The optimal fiduciary contract.** We have seen how the characteristics of the legal system and the protective measures included in the contract determine the set of Nash equilibria that are possible in the second and third stages of the game between the director and shareholders. Let us

now move to the first stage of the game. In this stage the shareholders' problem is to maximize firm value by offering a contract that solves

$$\max_{z,\mu,\lambda} U_s(z, \mu, \lambda)$$

subject to

$$U_d(z, \mu, \lambda) \geq w, \tag{7}$$

$$(\mu, \lambda) \in N(z), \tag{8}$$

$$s \geq 0,\ 0 \leq \alpha \leq 1,\ I \in \{0, 1\},\ \beta \in [0, 1). \tag{9}$$

Condition (7) guarantees that the contract satisfies the director's individual-rationality constraint, i.e., it induces him to accept the contract. Since $N(z)$ is the set of Nash equilibria of the subgame that comprises the second and third stages of the game, it follows that a solution (z^*, μ^*, λ^*) to this problem is a subgame-perfect equilibrium of the game.

In the remainder of this section I characterize the solution to this problem, proceeding in two steps. In this subsection I find the optimal contract $z^*(\mu, \lambda)$ that induces each of the possible equilibria

$$N \equiv \{(\mu, \lambda) \mid \exists\, z \text{ satisfying (7), (8), and (9)}\}.$$

In the next subsection I find a solution $z^*(\mu^*, \lambda^*)$ by maximizing the shareholders' payoff over the set N.

Lemma 2 and Lemma 3 describe the optimal contract $z^*(\mu, \lambda)$ that induces an equilibrium (μ, λ).

Lemma 2. We may assume without loss of generality that

(i) the optimal contract $z = (\alpha, s, I, \beta)$ that induces an equilibrium (μ, λ) with $\lambda \leq c_H/[(q_L p_L - q_H p_H)\min\{w, \beta D\}]$ includes a share in profits

$$\alpha = \frac{c_H - \lambda(p_L q_L - p_H q_H)\min\{w, \beta D\}}{(p_L - p_H)},$$

and a fixed salary,

$$s = \max\left\{0, \frac{\lambda[(1 - p_H)q_L p_L - (1 - p_L)q_H p_H]\min\{w, \beta D\} - (1 - p_L)c_H}{(p_L - p_H)}\right\},$$

and

(ii) the optimal contract $z = (\alpha, s, I, \beta)$ that induces an equilibrium (μ, λ) with $\lambda > c_H/[(q_L p_L - q_H p_H)\min\{w, \beta D\}]$ includes no share in profits, $\alpha = 0$, and a fixed salary,

$$s = \mu c_H + \lambda[\mu q_H p_H + (1 - \mu)q_L p_L]\min\{w, \beta D\}.$$

When the level of litigation is low, it is necessary to use contingent remuneration to provide incentives. This share in profits leaves the agent with a control rent, therefore no fixed salary is necessary to satisfy the individual-rationality constraint of the risk-neutral agent. As the level of litigation increases, α can be reduced. Notice that for a given level of litigation, α decreases as the wealth of the director w and/or the coinsurance rate β increases. The threat of litigation is a more powerful incentive the higher the amount that the director stands to lose.

If the level of litigation is very high, there is no need for contingent remuneration. But since the director will have to compensate the shareholders if he is found culpable at trial, the contract must offer a higher total compensation. This compensation is provided in the form of a fixed salary that is increasing in λ. Also notice that s increases as the wealth of the director w and/or

the coinsurance rate β increase. For a given level of litigation, wealthier directors and directors with lower protection will require a higher total compensation.

Lemma 3. We may assume without loss of generality that

(i) the optimal contract $z = (\alpha, s, I, \beta)$ that induces an equilibrium (μ, λ) where the shareholders litigate with probability lower than one ($\lambda < 1$) includes a cap on damages β such that $[\mu' q_H + (1 - \mu')q_L] \min\{w, \beta D\} = K$ whenever $[\mu' q_H + (1 - \mu')q_L] \min\{w, D\} > K$, and

(ii) the optimal contract $z = (\alpha, s, I, \beta)$ that induces an equilibrium (μ, λ) where the shareholders litigate with some positive probability ($\lambda > 0$) includes a liability insurance with a coinsurance rate β such that $\min\{w, \beta D\} = \min\{w, D\}$ whenever $[\mu' q_H + (1 - \mu')q_L]w < K$ and $[\mu' q_H + (1 - \mu')q_L]D \geq K$.

For a given level of litigation, the introduction of protective measures reduces the incentives to exercise a high level of care. Therefore they will not be used unless they are necessary to induce the desired level of litigation.

When, in the absence of protective measures, the expected damage award is so high that it induces the shareholders to always litigate, a cap on damages is necessary to induce equilibria with $\lambda < 1$. Similarly, when, in the absence of protective measures, the director's wealth w is so low that the shareholders will never litigate, liability insurance can induce equilibria with $\lambda > 0$ provided D is high enough.

As a general rule, β is set high enough so that the culpable director pays $\min\{w, D\}$, i.e., he does not profit *ex post* from the coverage of the liability insurance. But in equilibria with $\lambda < 1$, the coinsurance rate will be the highest possible that avoids overlitigation, i.e., β will be such that the culpable director will pay only $\min\{w, D, K/[\mu' q_H + (1 - \mu')q_L]\}$. Obviously, the results for the coinsurance rate would change if we considered a risk-averse manager. However, assuming risk neutrality makes it possible to show that liability insurance may be necessary to allow the shareholders to commit to a given litigation strategy.

Proposition 1 determines the division of surplus between the director and the shareholders in a given equilibrium (μ, λ).

Proposition 1. The optimal contract $z^*(\mu, \lambda)$ that implements an equilibrium (μ, λ) is such that under it, the director receives a control rent $(U_d(z^*(\mu, \lambda), \mu, \lambda) - w)$ equal to

$$\max\left\{0, \frac{(1 - p_L)c_H - \lambda\,[(1 - p_H)p_L q_L - (1 - p_L)p_H q_H] \min\{w, \beta D\}}{p_L - p_H}\right\},$$

where $\min\{w, \beta D\} = \min\{w, D\}$ if the shareholders have a strict preference for litigating against the defendant and $\min\{w, \beta D\} = \min\{w, D, \frac{K}{\mu' q_H + (1-\mu')q_L}\}$ otherwise. And the shareholders' utility is equal to

$$U_s(z^*(\mu, \lambda), \mu, \lambda) = (1 - p_H) - c_H - C - \big(U_d(z^*(\mu, \lambda), \mu, \lambda) - w\big) - \lambda\,[\mu p_H + (1 - \mu)p_L]\,K - (1 - \mu)(p_L - p_H - c_H).$$

On the one hand, litigation increases the shareholders' surplus because the control rent of the agent $(U_d(z^*(\mu, \lambda), \mu, \lambda) - w)$ is reduced relative to the case where recourse to the court is not possible. The director has an incentive to undertake a high level of care even if he does not obtain a share in the returns of the project. But on the other hand, the shareholders' surplus decreases because of the costs of litigation $\lambda[\mu p_H + (1 - \mu)p_L]K$ that the shareholders incur. Moreover, to induce litigation it may be necessary to induce a level of care μ lower than one, and this also decreases the shareholders' surplus by an amount $(1 - \mu)(p_L - p_H - c_H)$. Therefore, there is a tradeoff between extracting the control rents of the director, increasing the level of care, and reducing litigation costs. Interestingly, shareholders' utility increases as the wealth of the director w increases. The threat of litigation is a more powerful incentive for wealthier directors.

□ **Differences in litigation frequencies across firms and legal systems.** Proposition 1 identifies a tradeoff between extracting the control rents of the director, increasing the level of care, and reducing litigation costs. Given this tradeoff, the equilibrium levels of care and litigation will depend on the particular characteristics of the legal system D, q_L, q_H, K, the firm p_L, p_H, and the director's wealth w. Proposition 2 explains how these characteristics determine the solution $z^*(\mu^*, \lambda^*)$.

Proposition 2. The optimal contract z^* is such that

(i) if $q_H \min\{w, D\} \leq K$, there are two cases to consider depending on the value of $\min\{w, D\}$. For low (high) values of $\min\{w, D\}$ the director chooses the high level of care with probability one (lower than one) and the shareholders never litigate (litigate with a positive probability). Moreover, in equilibria where the shareholders litigate with positive probability, the optimal contract includes liability insurance whenever D is higher than w. The coinsurance rate is such that the director pays w when found culpable, and

(ii) if $K < q_H \min\{w, D\}$, there are two cases to consider depending on the value of the maximum control rent $(1 - p_L)c_H/(p_L - p_H)$ that the director can obtain. For low (high) values of this control rent, the director chooses the high level of care with probability one and the shareholders litigate with positive probability (always litigate). Moreover, in equilibria where the shareholders litigate with positive probability, the optimal contract includes a cap on damages such that the director only pays K/q_H when found culpable.

When the legal system is efficient enough so that the probability of punishing a nonculpable director is low (low q_H), the decision of the shareholders will depend on the potential damage award $\min\{w, D\}$. If $\min\{w, D\}$ is small relative to K, the shareholders will prefer not to litigate. When $\min\{w, D\}$ is small, the probability that the director is taken to court λ has to be very high in order to reduce control rents significantly. This results in very high legal costs, with the net effect of litigation on the shareholders' surplus being negative.

If $\min\{w, D\}$ is high enough relative to K, the amount of control rents that can be extracted from the director is high enough to compensate for the costs of litigation, and the shareholders will choose an equilibrium with litigation. To induce an equilibrium with a positive probability of litigation $\lambda \in [0, 1]$, however, the level of care induced by the contract has to be low enough to make shareholders' expected payoff from litigation positive *ex post* ($\mu = \overline{\mu}$). When $D > w$, we can raise the equilibrium level of care by buying liability insurance. If the coinsurance rate β is such that the culpable director always pays w, the adoption of liability insurance increases the shareholders' expected payoff for any level of care μ. Thus, by introducing liability insurance the shareholders can be induced to litigate with probability $\lambda \in [0, 1]$ for higher values of μ, increasing the shareholders' payoff.

When the legal system is inefficient in that the probability of punishing a nonculpable director is high (high q_H), the expected payoff from litigating against such a director is so high that, if no protective measures are introduced, the shareholders will litigate with probability $\lambda = 1$. By introducing a cap on damages, we can induce the shareholders to litigate with a lower probability, saving litigation costs without reducing the level of care. But the cap on damages reduces substantially the effective penalty that the director faces. So when the value of the maximum control rent that the director can obtain is large relative to K, no cap on damages will be introduced and the shareholders will sue the director with probability one.

Proposition 2 shows how the parties will use protective measures to introduce changes in the contract to adapt it to their particular characteristics. Therefore, the shareholders' utility will be higher when protective measures are allowed. This result is consistent with empirical evidence indicating that the adoption of D&O liability insurance creates value for the shareholders (Bhagat, Brickley, and Coles, 1987).

Proposition 2 also allows us to interpret the differences in the frequency of litigation and the use of protective measures that are observed across countries and across time. We can think of the situation in continental Europe as a case of underlitigation. The unavailability of liability insurance and/or the inefficiency of the legal system (low q_L and low D) result in an equilibrium where, for most firms, the shareholders never litigate because the reduction in control rents obtained through litigation does not compensate litigation cost. During the mid-1980s, the United States experienced a D&O insurance crisis: demand for liability insurance rose dramatically and many firms adopted LLPs. Romano (1991a) shows how both litigation frequency and damage awards increased sharply over this period and provides data suggesting that there was a simultaneous increase in legal uncertainty. The rise in the demand for D&O insurance is interpreted as the consequence of an increase in expected losses for risk-averse directors. I find a complementary explanation based on the changes in the shareholders' *ex post* incentives to litigate. According to Proposition 2, the increases in damage awards (D) and legal uncertainty (q_H) have three implications. First, as D becomes higher than w for more firms in the economy, the demand for liability insurance increases. Second, as the shareholders' *ex post* expected return from litigation increases, more firms will litigate in equilibrium. Third, as the *ex post* incentives to litigate increase, more firms will adopt caps on damages in order to avoid overlitigation.

5. Extensions

■ **Coordination problems among the shareholders and the use of LLPs.** During the insurance crisis, firms adopted LLPs instead of caps on damages. In my model, the introduction of liability insurance and caps on the amount of damages increases shareholder surplus, but there seems to be no role for LLPs. Nevertheless, it is possible to explain the widespread use of LLPs by U.S. firms by relaxing some of the model assumptions. In particular, LLPs will be adopted if caps on damages are not allowed, if there are coordination problems among the shareholders, or if there is uncertainty about the parameters of the model.

Proposition 3. When caps on damages are not allowed, the optimal contract will include LLPs when the value of the maximum control rent that the director can obtain is low compared to legal costs, and damage awards are so high as to induce overlitigation, i.e., when the following condition holds:

$$\frac{q_H(1 - p_L)c_H}{p_H(p_L - p_H)} < K < q_H \min\{w, D\}.$$

A cap on the amount of damages avoids overlitigation while also allowing for a reduction in control rents. The adoption of LLPs can prevent overlitigation, but it leaves the agent with a high control rent. So if caps on damages are not allowed, the shareholders will adopt LLPs only when litigation costs are high compared with the control rent that the agent obtains.

Even if caps on damages are allowed, coordination problems between the shareholders may make the adoption of LLPs necessary to reduce excessive *ex post* litigation.

By definition, the directors owe their fiduciary duties to the corporation as a legal personality and not directly to any particular shareholder. But to mitigate coordination problems among dispersed shareholders, the law allows any individual shareholder to take legal action against the directors in the name of all the shareholders. In this case, any proceeds from judgement will be equally divided between all the shareholders, and the corporation must pay for the legal costs of the successful plaintiff. Thus, the individual shareholder faces the same decision rule as all the shareholders as a group, i.e., equation (5).

However, some authors (Romano 1991a; Loewenstein, 1998) have documented cases of frivolous litigation in which a small shareholder (for whom the cost-benefit analysis in equation (5) is largely irrelevant) and his attorney (whose compensation is usually set on a contingency-fee basis) file the action seeking the award of attorneys' fees. This intrashareholder conflict may be formally introduced in the model by allowing a different decision rule for each shareholder.

Shareholder i will take the director to court if

$$\left[\mu' q_H + (1 - \mu')q_L\right]\left[\min\{w, \beta D\} + I(1 - \beta)D\right] + \theta_i \geq K.$$

If this is the case, the frequency of litigation will be determined by the decision rule of the shareholder with the highest θ_i. Moreover, if θ_i is private information, the shareholders will have difficulties in credibly committing to equilibria with a low probability of litigation by simply raising μ or by introducing caps on damages. Thus, the adoption of LLPs may be necessary to avoid equilibria with overlitigation.

Coordination problems among the shareholders may also appear if there is uncertainty about the wealth of the director. If w is not disclosed, *ex post* each shareholder will make the decision whether to litigate based on his estimation of the director's wealth. If this were the case, the wealthier directors would find the level of litigation too high to satisfy their individual-rationality constraints and would not accept the contract. To attract directors, the shareholders may be forced to renounce the legal system, adopting LLPs and providing incentives only through contingent compensation.

□ **Alternative monitoring devices.** The model does not consider the existence of alternative disciplining devices such as monitoring by large shareholders or creditors or an active takeover market. But since these devices are, to a large extent, exogenously given, their effects in the equilibrium of the game can be captured by changes in the parameters that reflect the characteristics of the firm.

Active monitoring may have two different effects. If monitoring increases the probabilty that the director is replaced after a bad performance, then monitoring increases the relative cost of a low level of care (equivalent to a reduction in c_H). Alternatively, active monitoring by large shareholders or creditors may supplement the care exerted by the director, making a low result less likely independent of the effort of the director (reducing both p_L and p_H).

A reduction in c_H reduces the need for both monetary and legal incentives and the equilibrium level of litigation. The effects of a reduction in both p_L and p_H are more ambiguous. On the one hand, the expected returns from the project for a given level of care increase. On the other hand, both contingent compensation and the threat of litigation become less powerful incentives to induce care, because the result from the project is less dependent on the director's level of care. Therefore, inducing a given level of care becomes more expensive. Depending on the parameters, the equilibrium level of litigation may increase or decrease. Moreover, a reduction in both p_L and p_H increases the expected net return when the director exercises a low level of care (equation (2)). Thus, it may be optimal to offer a fixed salary and induce an equilibrium with a low level of care and no litigation.

□ **Out-of-court settlement.** Up to now we have assumed that a filed case is always resolved in the courtroom. However, most duty-of-care cases are resolved by an out-of-court settlement. After the shareholders file the lawsuit, the parties try to reach a financial agreement before proceeding to trial. If an agreement is reached in this bargaining process, then the court will implement this agreement and the parties will incur lower legal costs. If an agreement is not reached, then the plaintiff may proceed to trial or drop the suit.

My model can easily be extended to include the possibility of renegotiation among the director and the shareholders.[11] The settlement game starts after the shareholders decide to file suit against the director. Then the settlement game proceeds as follows. First, the shareholders, the uninformed party, make a take-it-or-leave-it settlement offer to the director. Second, if the director accepts the settlement offer, the shareholders incur no legal costs. If the director rejects the offer, then shareholders may (i) drop the suit or (ii) go to trial, incurring legal costs K.

[11] The model of out-of-court settlement presented here is adapted from two of the first articles on pretrial negotiation with private information: Bebchuk (1984) and P'ng (1987). See also Spier (1992) and Nalebuff (1987).

If the director and the shareholders reach an agreement to settle for an amount S, and the director is insured, with a coinsurance rate β, or protected by a cap on damages, he will pay only a fraction βS, while the shareholders will receive $(\beta + I(1-\beta))S$.

There are three necessary conditions that must be satisfied for settlement to be feasible. First, the director will never settle if the litigation threat is not credible. Therefore, a necessary condition for settlement to occur is that the shareholders' payoff from litigation (without settlement) is positive, i.e., $\mu \leq \overline{\mu}$. Second, the shareholders will never offer an amount below their expected returns from trial. And third, the director will not accept any settlement offer above his expected loss at trial given his type.[12]

When these three necessary conditions are satisfied, if the shareholders have filed a lawsuit they can do one of three things. They can decide not to make any offer and proceed directly to court. If they decide to make a settlement offer, they can either offer to settle for a maximum amount

$$S_H^* = \frac{1}{\beta} q_H \min\{w, \beta D\}$$

that is acceptable to both the culpable and the nonculpable director, or they can offer to settle for a higher amount

$$\frac{1}{\beta} q_H \min\{w, \beta D\} < S_L \leq \frac{1}{\beta} q_L \min\{w, \beta D\}$$

that is acceptable only to the culpable director. If the shareholders offer to settle for S_L, some cases will settle and some will go to trial.

Proposition 4. The following strategy is a subgame-perfect equilibrium of the settlement game that starts after the shareholders make a take-it-or-leave-it offer to settle for S_L:

(i) if the director chose c_H, he rejects the offer;

(ii) if the director chose c_L, he may reject the offer with probability δ or accept the offer with probability $1 - \delta$, where

$$\delta = \frac{\mu}{(1-\mu)} \frac{K - q_H \left[\min\{w, \beta D\} + I(1-\beta)D\right]}{q_L \left[\min\{w, \beta D\} + I(1-\beta)D\right] - K};$$

and

(iii) if the director rejects the offer, the shareholders may go to trial with probability ρ or they may drop the action with probability $1 - \rho$, where

$$\rho = \frac{\beta S_L}{q_L \min\{w, \beta D\}}.$$

The shareholders' expected utility after they make an offer to settle for S_L is

$$\mu\rho \left(q_H \left[\min\{w, \beta D\} + I(1-\beta)D\right] - K\right) + (1-\mu)(1-\delta)(\beta + I(1-\beta))\, S_L$$
$$+ (1-\mu)\delta\rho \left(q_L \left[\min\{w, \beta D\} + I(1-\beta)D\right] - K\right).$$

With probability μ the director is not culpable and he rejects the offer. The first term represents the loss that will be incurred if the shareholders take this nonculpable director to court with probability ρ. With probability $(1-\mu)$ the director is culpable. If the culpable director accepts the settlement offer (which happens with probability $(1-\delta)$), the shareholders get S_L. If the culpable director rejects the offer (which happens with probability δ), the shareholders go to trial with probability ρ. The third term represents the expected gain at trial if the shareholders take this culpable director

[12] I assume the insurance company does not intervene in the settlement process. It can be shown that any settlement offer that is acceptable to the director is also acceptable to the insurance company.

to court. This utility is increasing in S_L. Therefore, the settlement offer that maximizes the shareholders' expected payoff is

$$S_L^* = \frac{1}{\beta} q_L \min\{w, \beta D\}.$$

Once a suit has been filed, the shareholders will either proceed directly to court, offer to settle for S_H^*, or offer to settle for S_L^*, depending on which of these three options offers the highest payoff at this stage. Notice that when settlement is possible and costless, the *ex post* expected payoff from suing and trying to settle is always strictly positive, ($S_H^* > 0$). Therefore, provided that $\mu \leq \overline{\mu}$, the shareholders will always sue, i.e., $\lambda = 1$.

It is now possible to characterize the subgame-perfect equilibrium of the game as the vector (z, μ, λ, S_i) that maximizes the shareholders' profits subject to the director accepting the contract and given the restrictions imposed by the legal system on the values of s, α, I, and β.[13]

Allowing for settlement has three effects on the shareholders' surplus. First, once the shareholders file a suit, the expected litigation costs are lower if settlement is allowed. Second, the level of litigation increases when costless settlement is allowed because the shareholders' expected payoff from litigation is always positive. Therefore, the effect of settlement on total litigation costs is ambiguous. Third, settlement introduces the possibility of renegotiation between the shareholders and the director. This makes it more costly to extract the control rent from the director because in order to do it the shareholders must commit not to settle. Hence, given these three effects, the total effect on the shareholders' surplus is ambiguous. However, the results regarding the use of liability insurance are maintained when we allow for out-of-court settlement.

Proposition 5. We may assume without loss of generality that

(i) the optimal contract $z = (\alpha, s, I, \beta)$ that induces an equilibrium (μ, λ, S_j^*) where the shareholders do not litigate ($\lambda = 0$) includes a cap on damages whenever

$$\left[\mu' q_H + (1 - \mu') q_L\right] \min\{w, D\} > K;$$

and

(ii) the optimal contract $z = (\alpha, s, I, \beta)$ that induces an equilibrium (μ, λ, S_j^*) where the shareholders always litigate ($\lambda = 1$) includes a liability insurance with a coinsurance rate β such that $\min\{w, \beta D\} = \min\{w, D\}$ whenever $w < D$.

Liability insurance will still be useful because it allows the shareholders to implement an equilibrium with litigation even when the director's wealth w is too low to cover litigation expenses provided that D is high enough. Just as before, when $\min\{w, D\}$ is high relative to K, if no protective measures are adopted, the only possible equilibria are those where the shareholders always litigate $\lambda = 1$. If this is the case, a cap on damages is necessary to induce an equilibrium with no litigation. Notice, however, that the incentives to litigate can be reduced by raising the level of care μ. And since we are assuming that settlement is costless, an equilibrium with ($\mu = 1, \lambda = 1, S_j^* = S_H^*$) always gives the shareholders a higher payoff than an equilibrium with ($\mu = 1, \lambda = 0$), because it allows for some rent extraction, and no litigation costs are incurred. Thus, under the assumption that settlement is costless, there is no role for the use of a cap on damages. However, this last result depends critically on the assumption of costless settlement. Being involved in a suit, even if trial is avoided, may have substantial costs because it affects the firm's reputation. If we introduce settlement costs $K' < K$ in the model, the threat of overlitigation will induce the shareholders to adopt caps on damages for some values of the parameters, in particular if control rents are low or can be reduced through the use of alternative control mechanisms.

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[13] A complete characterization of the equilibrium of the game that allows for out-of-court settlement is available from the author upon request.

6. Conclusions

■ The purpose of this article has been to explain how the legal liability rules that directors face can be designed to provide them with the incentives to fulfill their fiduciary duties and to maximize *ex ante* share value.

The main result is that the simultaneous occurrence of very high damage awards and the widespread use of liability insurance and limited-liability provisions that is currently observed in the United States is optimal because it allows for a more efficient litigation strategy to be *ex post* rational for shareholders.

When litigation is costly, the damage award has to be high enough to give the shareholders the incentive to litigate. But when protective measures are not allowed, depending on the characteristics of the firm and the director (in particular, the director's wealth and level of control rents that he can obtain), the same damage award will result in too much or too little litigation taking place. When the director's wealth is low, the incentives for the shareholders to sue can be maintained only through the adoption of an insurance policy (that guarantees the shareholders will receive the full amount of the damage award). When the director's wealth is high, a high damage award may induce the shareholders to litigate even if the probability that the director is culpable is very low, i.e., they will litigate too often. In this case the use of a cap on damages (that reduces the damage award that shareholders can obtain) can solve the problem. These results suggest that the existing legal rules are designed to optimally fill the gaps in the contracts between shareholders and directors.

Appendix

■ Proofs of Lemmas 1–3 and Propositions 1–5 follow.

Proof of Lemma 1. When protective measures are not allowed, substituting $I = 0$ and $\beta = 1$ into (5) gives

$$\bar{\mu} = \frac{p_L q_L \min\{w, D\} - p_L K}{(p_L q_L - p_H q_H)\min\{w, D\} - (p_L - p_H)K}.$$

When protective measures are allowed if $K \leq q_L D$, we can always find values of I and β such that $\bar{\mu} = \mu \; \forall \mu \in (0, 1)$. The result then follows immediately from the discussion of the possible strategies. *Q.E.D.*

Proof of Lemma 2. Let contract $z(\mu, \lambda) = (\alpha, s, I, \beta)$ be the optimal contract that induces an equilibrium (μ, λ). Contract z must satisfy (7), (8), (9), and the incentive-compatibility constraint (IC) of the agent.

If

$$\lambda < \frac{c_H (1 - p_L)}{[(1 - p_H) q_L p_L - (1 - p_L) q_H p_H] \min\{w, \beta D\}},$$

any α satisfying (IC) also satisfies (7) for any value of s. Consider the alternative contract $\hat{z} = (\hat{\alpha}, \hat{s}, I, \beta)$, where

$$\hat{\alpha} = \frac{c_H - \lambda (p_L q_L - p_H q_H)\min\{w, \beta D\}}{(p_L - p_H)}$$

and $\hat{s} = 0$.

If

$$\lambda > \frac{c_H}{(q_L p_L - q_H p_H)\min\{w, \beta D\}},$$

(IC) is trivially satisfied. All combinations of α and s satisfying (7) with equality leave the shareholders with the same payoff. Consider the alternative contract $\hat{z} = (\hat{\alpha}, \hat{s}, I, \beta)$, where $\hat{\alpha} = 0$ and $\hat{s} = \mu c_H + \lambda[\mu q_H p_H + (1 - \mu) q_L p_L] \min\{w, \beta D\}$.

For intermediate values of λ, the minimum value of α that satisfies (IC) also satisfies (7) with equality for a high-enough s. Moreover, all combinations of α and s satisfying (7) with equality leave the shareholders with the same payoff. Consider the alternative contract $\hat{z} = (\hat{\alpha}, \hat{s}, I, \beta)$, where

$$\hat{\alpha} = \frac{c_H - \lambda (p_L q_L - p_H q_H)\min\{w, \beta D\}}{(p_L - p_H)}$$

and

$$\hat{s} = \frac{\lambda[(1 - p_H)q_L p_L - (1 - p_L)q_H p_H]\min\{w, \beta D\} - (1 - p_L)c_H}{(p_L - p_H)}.$$

Contract $\hat{z}$ always satisfies (7), (8), (9), and (IC). Therefore, contract $\hat{z}$ also induces (μ, λ) and, since (3) is decreasing in s and α, gives the shareholders a higher payoff than contract z. *Q.E.D.*

Proof of Lemma 3. Let $z = (\alpha, s, I, \beta)$ be the optimal contract that induces (μ, λ). Substituting for the optimal α and s into (3), we can see that the shareholders' payoff is increasing in β for $\beta < w/D$. Therefore, β must be the highest possible value that induces (μ, λ). The result then follows from the comparison of μ and (5) for $\lambda = 1$, $\lambda = 0$, and $\lambda \in (0, 1)$ respectively. *Q.E.D.*

Proof of Proposition 1. It follows directly from Lemmas 2 and 3 by substituting the optimal values of α, s, I, and β into equations (4) and (3). *Q.E.D.*

To prove Proposition 2 we will use Lemma A1.

Lemma A1. We can find a solution $(z^*(\mu^*, \lambda^*), \mu^*, \lambda^*)$ by maximizing over the set $N' \equiv \{(\mu = 1, \lambda = 0); (\mu = 1, \lambda = 1); (\mu = \overline{\mu} = \min\{1, \hat{\mu}\}, \lambda = \overline{\lambda} = \min\{1, \hat{\lambda}\})\}$, with

$$\hat{\mu} = \frac{p_L q_L D - p_L K}{(p_L q_L - p_H q_H)D - (p_L - p_H)K}$$

and

$$\hat{\lambda} = \frac{(1 - p_L)c_H}{[(1 - p_H)p_L q_L - (1 - p_L)p_H q_H]\min\left\{w, D, \dfrac{K}{q_H}\right\}}.$$

Proof of Lemma A1. In an equilibrium where the shareholders have a strict preference not to litigate ($\lambda = 0$), we know by Proposition 1 that the shareholders' expected payoff is increasing in μ. Moreover, μ has to satisfy $\mu > \overline{\mu}$. Therefore, it is optimal to set $\mu = 1$.

In an equilibrium where the shareholders are indifferent about litigating ($\lambda \in [0, 1]$), the shareholders' expected payoff is decreasing in λ for $\lambda > \tilde{\lambda}$, with

$$\tilde{\lambda} = \frac{(1 - p_L)c_H}{[(1 - p_H)p_L q_L - (1 - p_L)p_H q_H]\min\left\{w, D, \dfrac{K}{[\mu' q_H + (1 - \mu')q_L]D}\right\}}.$$

For $\lambda \leq \tilde{\lambda}$ there are two possible cases. If $U_s(z^*(\mu, \lambda), \mu, \lambda)$ is increasing in λ for $\lambda \leq \tilde{\lambda}$, the optimal value of λ is $\lambda = \min\{1, \tilde{\lambda}\}$. And given $\lambda = \min\{1, \tilde{\lambda}\}$, the shareholders' payoff is increasing in μ. But μ has to satisfy $\mu = \overline{\mu}$, and the maximum possible value of $\overline{\mu}$ is $\hat{\mu}$. Therefore, it is optimal to set $\mu = \min\{1, \hat{\mu}\}$. Then $[\mu' q_H + (1 - \mu')q_L]D = q_H$. If $U_s(z^*(\mu, \lambda), \mu, \lambda)$ is decreasing in λ for $\lambda \leq \tilde{\lambda}$, the optimal value of λ is $\lambda = 0$. But $\lambda = 0 \Rightarrow U_s(z^*(1, 0), 1, 0) \geq U_s(z^*(\mu, 0), \mu, 0)$. Therefore, it is optimal to set $\mu = 1$.

In an equilibrium where the shareholders have a strict preference for litigation ($\lambda = 1$), the shareholders' expected payoff is increasing in μ. However, μ has to satisfy $\mu < \overline{\mu}$, with $\overline{\mu} \leq \hat{\mu} < 1$. Moreover, $\mu < \hat{\mu} < 1 \Rightarrow U_s(z^*(\mu, \lambda), \mu, \lambda) \geq U_s(z^*(\mu, 1), \mu, 1)$. Therefore, the only pure-strategy equilibrium with $\lambda = 1$ that can be optimal is $(1, 1)$. *Q.E.D.*

Proof of Proposition 2. We know by Lemma A1 that we can find a solution $(z^*(\mu^*, \lambda^*), \mu^*, \lambda^*)$ by maximizing the shareholders' payoff over the set N'. There are two different cases to consider:

(i) When $q_H \min\{w, D\} < K \leq q_L D$, both $(1, 0)$ and $(\overline{\mu}, \overline{\lambda})$ are possible and $\overline{\mu} = \hat{\mu} \leq 1$. The difference $U_s(z^*(\overline{\mu}, \overline{\lambda}), \overline{\mu}, \overline{\lambda}) - U_s(z^*(1, 0), 1, 0)$ increases in $\min\{w, D\}$. It is negative if $\min\{w, D\} = 0$ and positive if $\min\{w, D\} = K/q_H$.

(ii) When $K < q_H \min\{w, D\}$, all $(1, 0)$ $(1, 1)$, and $(\overline{\mu} = 1, \overline{\lambda})$ are possible equilibria, but $U_s(z^*(\overline{\mu}, \overline{\lambda}), \overline{\mu}, \overline{\lambda}) - U_s(z^*(1, 0), 1, 0) \geq 0$. Thus, we only need to compare the difference $U_s(z^*(\overline{\mu}, \overline{\lambda}), \overline{\mu}, \overline{\lambda}) - U_s(z^*(1, 1), 1, 1)$, which is positive if $\overline{\lambda} = \hat{\lambda} < 1$ and negative otherwise.

Finally, the results on the use of protective measures follow immediately from Lemma 3. *Q.E.D.*

Proof of Proposition 3. When $K < q_H \min\{w, D\}$, we know by Proposition 2 that if caps on damages are not allowed, the only possible equilibria in set N' are $(\mu = 1, \lambda = 1)$ and, if LLPs are allowed, $(\mu = 1, \lambda = 0)$. The result then follows by computing the values of K for which the difference $U_s(z^*(1, 0), 1, 0) - U_s(z^*(1, 1), 1, 1)$ is positive. *Q.E.D.*

Proof of Proposition 4. After S_L is rejected, shareholders update the probability that the director is not culpable given that he has rejected the offer to $\mu' = \mu p_H/[\mu p_H + (1-\mu)p_L\delta]$. The expected payoff from going to trial is $(\mu' q_H + (1-\mu')q_L)[\min\{w, \beta D\} + I(1-\beta)D] - K$. The shareholders are indifferent between going to trial and dropping the action if and only if this payoff is zero,

$$\delta = \frac{\mu p_H \left(K - q_H \left[\min\{w, \beta D\} + I(1-\beta)D\right]\right)}{(1-\mu)p_L \left(q_L \left[\min\{w, \beta D\} + I(1-\beta)D\right] - K\right)}.$$

The nonculpable director will never settle for S_L because he is better off going to trial. Given ρ, the culpable director's expected payoff if he does not settle for S_L is $-\rho q_L \min\{w, \beta D\}$. Therefore he is indifferent between accepting or rejecting an offer to settle for S_L if $\rho = \frac{\beta S_L}{q_L \min\{w, \beta D\}}$. *Q.E.D.*

To prove Proposition 5 we must first characterize the shareholders' problem for the game with out-of-court settlement. Let S_j^* denote the settlement offer of the shareholders ($j = 0, H, L$). Making an offer $S_0^* > S_L^*$ is equivalent to proceeding directly to court, because the director will never settle for that amount. Let δ_{ij} denote the probability that the defendant of type i rejects an offer to settle for S_j^*. Let ρ_j denote the probability that the shareholders go to trial when the director refuses to settle for S_j^*. Notice that $\delta_{i0} = 1$, $\delta_{iH} = 0$, $\delta_{HL} = 1$, $\delta_{LL} = \delta$, $\rho_0 = \rho_H = 1$, and $\rho_L = \rho$. Finally, let μ_i denote the probability that the director chooses the level of care c_i. Notice that $\mu_H = 1 - \mu_{HL} = \mu$. The payoff functions of the game that allow for out-of-court settlement can be rewritten as

$$\begin{aligned} U_s(z, \mu, \lambda, S_j^*) = {} & (1-\alpha) \sum_{i=H,L} \mu_i(1-p_i) - s - C \\ & + \lambda \sum_{i=H,L} \mu_i p_i \delta_{ij} \rho_j \left(q_i \min\{w, \beta D\} - K\right) + \lambda \sum_{i=H,L} \mu_i p_i (1-\delta_{ij}) q_j \min\{w, \beta D\} \\ & + I\lambda \sum_{i=H,L} \mu_i p_i \left(\delta_{ij}\rho_j q_i + (1-\delta_{ij})q_j\right)(1-\beta)D \\ & - I\lambda^*(z) \sum_{i=H,L} \mu_i^*(z) p_i \left(\delta_{ij}\rho_j q_i + (1-\delta_{ij})q_j\right)(1-\beta)D, \end{aligned} \tag{A1}$$

$$\begin{aligned} U_d(z, \mu, \lambda, S_j^*) = {} & \alpha \sum_{i=H,L} \mu_i(1-p_i) + s \\ & - \lambda \sum_{i=H,L} \mu_i p_i \delta_{ij} \rho_j q_i \min\{w, \beta D\} \\ & - \lambda \sum_{i=H,L} \mu_i p_i (1-\delta_{ij}) q_j \min\{w, \beta D\} - \mu c_H + w. \end{aligned} \tag{A2}$$

Consider the settlement stage. After suing, the shareholders will offer to settle for S_H^* if and only if $\mu > \max\{\mu_{H0}, \mu_{HL}\}$, where μ_{H0} and μ_{HL} are the values of μ that satisfy that the shareholders' expected payoff is equal when they offer S_H^* and when they offer S_0^* and S_L^* respectively:

$$\mu_{HL} = \frac{q_L \left[\min\{w, \beta D\} + I(1-\beta)D\right] - K}{q_L \left[\min\{w, \beta D\} + I(1-\beta)D\right]}, \tag{A3}$$

$$\mu_{H0} = \frac{(q_L - q_H)\left[\min\{w, \beta D\} + I(1-\beta)D\right] - K + q_H \dfrac{I(1-\beta)\left[\beta D - \min\{w, \beta D\}\right]}{\beta}}{(q_L - q_H)\left[\min\{w, \beta D\} + I(1-\beta)D\right]}. \tag{A4}$$

If $\mu \leq \max\{\mu_{H0}, \mu_{HL}\}$, the shareholders will offer S_L^* if and only if

$$K \geq q_H \frac{I(1-\beta)}{\beta}(\beta D - \min\{w, \beta D\}), \tag{A5}$$

and S_0^* if and only if this last condition does not hold.

Consider now the third stage. Because the expected payoff that the shareholders can obtain from the settlement process is always positive ($S_H^* > 0$), they will sue with probability $\lambda = 1$ whenever

$$\mu \leq \overline{\mu} = \frac{q_L \left[\min\{w, \beta D\} + I(1-\beta)D\right] - K}{(q_L - q_H)\left[\min\{w, \beta D\} + I(1-\beta)D\right]}. \tag{A6}$$

Otherwise they will not sue $\lambda = 0$.

In the second stage the director will play $\mu \in (0, 1]$ when his utility when he plays c_H is equal to his utility when he plays c_L. Therefore he will play $\mu \in (0, 1]$ if $\lambda = \bar{\lambda}$:

$$\bar{\lambda} = \frac{c_H - \alpha(p_L - p_H)}{\left[p_L\left(\delta_{Lj}\rho_j q_L + (1 - \delta_{Lj})q_j\right) - p_H\left(\delta_{Hj}\rho_j q_H + (1 - \delta_{Hj})q_j\right)\right]\min\{w, \beta D\}}. \tag{A7}$$

and $\mu = 1$ if $\lambda > \bar{\lambda}$.

Therefore the set of Nash equilibria of the subgame that comprises the second, third, and settlement stage of the game $N^S(z)$ is

$$N^S(z) = \begin{cases} (\mu, 0) & \mu \in (0, 1] \text{ if } \bar{\lambda} = 0 \text{ and } \mu = 1 \text{ if } \bar{\lambda} < 0, \\ (\mu, 1, S_H^*) & \mu \in (\max\{\mu_{HL}\mu_{H0}\}, \min\{1, \overline{\mu}\}] \text{ and } \bar{\lambda} = 1, \\ (\mu, 1, S_L^*) & \mu \in (0, \mu_{HL}] \text{ and } \bar{\lambda} = 1, \\ (\mu, 1, S_0^*) & \mu \in (0, \mu_{H0}] \text{ and } \bar{\lambda} = 1. \end{cases}$$

In the first stage the shareholders' problem is to maximize firm value by offering a contract that solves

$$\max_{z, \mu, \lambda, S_j^*} U_s(z, \mu, \lambda, S_j^*)$$

subject to

$$U_d(z, \mu, \lambda, S_j^*) \geq w, \tag{A8}$$

$$(\mu, \lambda, S_j^*) \in N^S(z), \tag{A9}$$

$$s \geq 0,\ 0 \leq \alpha \leq 1,\ I \in \{0, 1\},\ \beta \in [0, 1). \tag{A10}$$

Now it is possible to find a solution $z^*(\mu^*, \lambda^*, S_j^*)$ of the game that allows for out-of-court settlement following the same steps as in the previous section.

To prove Proposition 5, we will use use Lemma A2 (the out-of-court analog of Lemma 2).

Lemma A2. We may assume without loss of generality that

(i) the optimal contract $z = (\alpha, s, I, \beta)$ that induces an equilibrium (μ, λ, S_j^*) with

$$\lambda \leq \frac{c_H}{\min\{w, \beta D\}\left(p_L\left[\delta_{Li}\rho_j q_L + (1 - \delta_{Lj})q_j\right] - p_H\left[\delta_{Hj}\rho_j q_H + (1 - \delta_{Hj})q_j\right]\right)}$$

includes a share in profits

$$\alpha = \frac{c_H - \lambda \min\{w, \beta D\}\left(p_L[\delta_{Li}\rho_j q_L + (1 - \delta_{Lj})q_j] - p_H[\delta_{Hj}\rho_j q_H + (1 - \delta_{Hj})q_j]\right)}{p_L - p_H},$$

and a fixed salary $s = \max\{0, \bar{s}\}$, with

$$\bar{s} = \frac{\lambda \min\{w, \beta D\}\left((1 - p_H)\, p_L\left[\delta_{Lj}\rho_j q_L + (1 - \delta_{Lj})q_j\right] - (1 - p_L)\, p_H\left[\delta_{Hj}\rho_j q_H + (1 - \delta_{Hj})q_j\right]\right)}{(p_L - p_H)} - \frac{(1 - p_L)c_H}{(p_L - p_H)},$$

and

(ii) the optimal contract $z = (\alpha, s, I, \beta)$ that induces an equilibrium (μ, λ, S_j^*) with a higher λ includes no share in profits, $\alpha = 0$, and a fixed salary $s = \lambda \sum_{i=H,L} \mu_i p_i(\delta_{ij}\rho_j q_i + (1 - \delta_{ij})q_j) \min\{w, \beta D\} + \mu c_H$.

Proof of Lemma A2. The proof follows the same reasoning as the proof of Lemma 2. *Q.E.D.*

Proof of Proposition 5. The proof follows the same reasoning as the proof of Lemma 3, using the results from Lemma A2. *Q.E.D.*

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