An Economic Analysis of Corporate Directors' Fiduciary Duties

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Abstract

This paper studies how the legal liability rules for directors can be optimally designed to provide them with the incentives to fulfill their fiduciary duties and to maximize ex-ante firm value. I present a principal-agent model where the shareholders can obtain a verifiable but costly and imperfect signal on the director's fulfillment of his fiduciary duties by taking legal action against him. This allows the firm to make the director's remuneration contingent not only on performance but also upon the court's decision. The paper shows that, when damages awards are high, the widespread use of liability insurance and limited liability provisions that is observed in the US is optimal because it allows shareholders to credible commit to an optimal suing strategy. The results on the use of liability insurance are maintained when the parties can settle out of court.

Keywords: corporate governance; fiduciary duties; directors' remuneration; Directors and Officers liability insurance; Limited Liability Provisions

JEL classification: G30; K40

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 that mere independence.

This paper studies how the characteristics of the legal system and the specific regulation of fiduciary duties affect the contractual relationship between shareholders and directors. Specifically we consider how changes in the level of the damages awards, the 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 how this, in turn, alters the optimal fiduciary contract that maximizes firm value.

[1] Extracted from a selection of interviews with over 100 directors conducted by Lorsch and MacIver (1989, p. 81), this quote 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).

I present a principal-agent model where the shareholders can obtain a verifiable but costly and imperfect signal on the director's fulfillment of his fiduciary duties by taking legal action against him. This allows the firm to make the director's remuneration contingent not only on performance but also upon the court's decisions.

The paper shows that the simultaneous occurrence of very high damages awards and a widespread use of liability insurance and limited liability provisions that is currently observed in the US is consistent with shareholders' profit maximization. The high damages awards give the shareholders the necessary incentives to initiate legal proceedings in case of conflict. The possibility for the shareholders to protect the directors with a liability insurance or other protective measures allows the shareholders to credibly commit to the litigation strategy that maximizes firm value. Moreover, the results on the use of liability insurance are maintained when the possibility of renegotiation is introduced by allowing parties to settle out of court.

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 US and in Continental Europe.

Directors are held personally liable for failure to comply with their fiduciary duties and can be sentenced to pay both compensatory and punitive damages to the shareholders. The liability rules fix aspects of procedure, burden of proof, and damages. In the US, a 1995 survey conducted over 500 outside directors by Louis Harris & Associates found out that 40% of them had been sued in their capacity as an outside director, and a 1996 survey conducted over 1000 firms by the Wyatt Company revealed that 30% of them had experienced one or more claims against their directors with the shareholders as the most frequent class of claimants. 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). As a matter of fact, the legal rules about professional liability have experienced several changes over the last three decades and there are important differences between the states legislatures (Campbell et al., 1995). In Continental Europe the situation is very different. Directors are sued in cases of fraud but suits for breaches of fiduciary duties are rare and condemnatory sentences are even rarer.[3] Nevertheless the number of claims has increased in the last years and there have been changes in liability rules that "increase" the legal liability of directors.[4]

However these important differences in liability rules seem to be compensated by the widespread use of liability insurance and limited liability provisions by American firms. Over 90% of Fortune 1000 company directors are covered by a *directors and officers liability policy* (Louis Harris and Associates, 1995). Under a typical D&O liability policy the insurance company will pay on behalf of the director the loss resulting from claims against him

[3]In Spain during the period between 1951 and 1990 the Supreme Court passed sentence on only twelve cases of shareholder derivative litigation, and in most of them it ruled in favour of the defendant (J&A Garrigues Abogados, 1996).

[4]In Spain, the new Ley de Sociedades Anónimas of 1989 makes the burden of the proof fall on the defendant.

for breaches of fiduciary duties that do not constitute fraudulent acts. Many firms have also adopted *limited liability provisions* (LLPs) in their statutes.[5] These statutory provisions effectively eliminate the directors' personal liability for monetary damages to the shareholders.

Some claim that these are examples of how directors have been successful in isolating themselves from the court discipline (Bishop, 1981). In Continental Europe changes in the statutes limiting the directors' liability are forbidden and D&O insurance is very rarely used and it is forbidden in Germany where the legislator considers that the use of this type of insurance would both reduce the levels of diligence of directors and increase the compensatory demands of plaintiffs.[6]

However there is some empirical evidence indicating that the adoption of D&O liability insurance and LLPs creates value for the shareholders (Bhagat et al., 1987; Brook and Rao, 1994). These authors argue that D&O liability insurance and LLPs allow the firm to contract better directors (Warther, 1998). Their argument is that, given the high level of damages awards, fear of personal liability will reduce the number of able risk-averse individuals willing to serve as directors. A partial liability insurance can solve this problem and still give directors enough incentives to fulfil their duties. They argue that limited liability provisions are the only option for companies that cannot afford the high premiums charged by the insurance companies.[7] Further,

[5] After the majority of American jurisdictions adopted statutes that allowed LLPs in 1996 more than 70% of large publicly held corporations amended their articles of incorporation to include these provisions.

[6] In Spain although it is possible to contract this type of insurance, the insurance companies have been reluctant to offer these policies (J&A Garrigues Abogados, 1996).

[7] During the 1980s both the number of lawsuits against corporate boards and the costs of defense and fines of these lawsuits increased dramatically. Most of the claims where

there are alternative incentives such as performance sensitive compensation that discipline directors without imposing unfair risks on them. In fact, the use of share-option schemes to compensate outside directors is also more common in the USA than in Continental Europe where directors usually get a fix pay.[8]

But the obvious question to ask is why are the damages awards so high in the first place. If liability insurance and LLPs are the response to inefficiently high damages awards social welfare could be improved by allowing the companies to place caps to the amount of damages that their directors should pay. In fact this alternative was proposed by the American Law Institute (ALI) in its Corporate Governance Project. However this proposal has been ignored and the states have instead adopted exculpatory statutes that allow companies to introduce LLPs.

The model presented here allows us to answer this question by determining how firm value and the protective measures included in the optimal fiduciary contract change with the characteristics of the legal system.

The remainder of the paper is organized as follows. The following section briefly summarizes the related literature. The model and the results are presented in Sections 3 and 4, respectively. Section 5 explains how the results change when out-of-court settlement is allowed. Finally Section 6 concludes.

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related to takeovers, IPOs, and business failures. The response of the D&O insurers was a huge increase in premiums and limitation of coverage for the corporations that were able to afford the premiums (Romano, 1991; Winter, 1991).

[8]The adequacy of this type of compensation is subject to debate and the different corporate governance codes of best practice make conflicting recommendations regarding the use of these schemes to compensate directors: while the Greenbury report advises the use of performance related remuneration to give directors incentives to perform, the Cadbury report considers that their use may compromise their independence.

2 Related literature

The model presented here builds on previous work that has adapted the principal-agent framework to include the possibility of litigation.[9]

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 when the principal cannot precommit to not litigate. 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 over-litigation, 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 considers the effect of insurance and the level of penalties on the principal's incentive to litigate but

[9] See for instance Simon (1981) and P'ng (1987).

differs from Sarath's model in several respects.

Unlike in his model, the uncertainty of the legal system is not due to an 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 the insurance for the agent. Another important difference is that here the level of the penalty cannot be optimally chosen by the principal. The expected level of the penalty is imposed exogenously as the average penalty that is being currently awarded by the courts, and it may change over time. Furthermore the model presented here explicitly considers the possibility of out-of-court settlement that has not been studied in this optimal contracting framework. Finally, although the results can be extrapolated to a general principal-agent problem, the model focuses on the contractual problems between shareholders and corporate directors and on the effects of protective measures on derivative litigation. This makes it possible to contrast the predictions of the model with the legal regulation of fiduciary duties.

In both Shavell (1982) and Sarath (1991) the only reason why the agent may buy insurance is to reduce his exposure to risk. In the model presented here the principal may buy insurance for the agent for the same reason, but more interestingly, he may also buy insurance to alter his ex-post incentives to litigate. For simplicity and in order to focus attention on this second reason it will be assumed that the director is risk-neutral. Therefore it is shown that, even when the agent is risk-neutral, restricting the level of insurance can never be optimal, and that allowing additional protective measures such as a cap to damages and LLPs allows the principal to avoid over-litigation.

3 The model

3.1 Agents and payoffs

Consider a publicly held firm where 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.[10] 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, c_H, and a low level of care, c_L. The parameter c_i $(i = H, L)$ represents the disutility of care for the director in monetary terms. Exerting a higher level of care is costly. For simplicity and without loss of generality I assume that $c_H > c_L = 0$. The level of care is not observable.

The project has a cost C and its return can be high, x_H, or low, x_L. Again, for simplicity and without loss of generality I assume that $x_H = 1$ and $x_L = 0$. 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.[11]

[10] 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.

[11] In this setting the difference between a low and a high return can be better interpreted as a reduction in the market value of the firm caused by the failure to accept or reject a merger, losses incurred due to a wrong acquisition, fines imposed on the company for not

Throughout the paper 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 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.

3.2 The legal system

After the return from the project is observed the shareholders can take legal action against the director. By undertaking legal action 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.[12] For simplicity I assume that the sued director does not pay legal fees (alternatively his legal fees are paid for by the shareholders).

The court applies a negligence rule. This means that for a breach of the duty of care to exist there must be a damage to the corporation caused by

complying with legal rules about pollution, disclousure of information, etc. All of these interpretations require that the director makes a decision subject to error of judgement.

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

a negligent action of the director. Therefore only when the project yields a low return the shareholders can file a suit. The court then observes a signal on the level of care to determine whether the director was negligent. The signal can be high, y_H, or low, y_L. Let q_i denote the probability 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 (not) exert a high level of care and will be interpreted as evidence of innocence (guiltiness).

Because the court does not directly observe the level of care but only an imperfect signal, this is an "imperfect" negligence rule. Notice however that this set up incorporates both the perfect negligence and the strict liability rules as limit cases. In a perfect *negligence rule* $q_L = (1 - q_H) = 1$, while in a *strict liability rule* $q_L = q_H = 1$. The results presented below are valid for both cases.

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 is sentenced to pay D to the shareholders he will then 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 to the amount of damages* that the director should pay if found guilty. Under this mechanism if the director is sentenced to pay D the shareholders will only receive the fraction $\min\{w, \beta D\}$.

Table 1 summarizes the different mechanisms. 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 to the damages award. In these four cases when the court finds the director guilty he pays $\min\{w, \beta D\}$ and the shareholders receive $\min\{w, \beta D\} + I(1 - \beta)D$.

	I	β
No protective measures	0	1
D&O Liability Insurance	1	$\beta \in [0, 1)$
LLPs	0	0
Cap to damages	0	$\beta \in [0, 1)$

Table 1. Possible values of I and β.

3.3 The contract

The remuneration of the director can be made contingent on the result of the project and/or on the court's sentence. 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 non-negative in order to comply with limited liability rules. The incentive scheme must also comply with the legal regulation that may impose restrictions on the values of I and β depending on the type of protective measures allowed.

3.4 Timing

The timing of the game is summarized in the following time line:

t=1	t=2	t=3	t=4
-Shareholders offer contract (z)	-Director chooses level of care (μ)	-Return of project realized (x_H or x_L) -Shareholders decide whether to sue (λ)	-Court observes signal (y_H or y_L) and gives its verdict -Payoffs realized

Figure 1. Sequence of events.

At t=1 the shareholders offer a contract $z \equiv (s,\ \alpha,\ I,\ \beta)$ to the director such that the director decides to accept it. At t=2 the director chooses the level of care, c_H or c_L. The strategy space of the director is $A_d = \{c_H, c_L\}$, and the probability that the director chooses c_H will be denoted by $\mu \in [0, 1]$. At t=3 the return of the project, x_H or x_L, is realized and the shareholders decide whether to initiate legal proceedings at a cost K. The strategy space of the shareholders is $A_s = \{P, N\}$, and the probability that the shareholders proceed against the director (they choose P) will be denoted by $\lambda \in [0, 1]$. Finally, at t=4 the court observes the signal, y_H or y_L, and gives its verdict. Payoffs are then realized. The informational structure is such that except for the director's level of care all the other variables are observable.

3.5 Equilibrium concept and strategy for the analysis

Formally this is a three stage dynamic game of complete but imperfect information, by which we mean that the player's payoff functions are common knowledge but at each stage of the game the player that moves may not know the full history of the play of the game thus far. In the first stage the shareholders' problem is to offer a contract to the director that satisfies his individual rationality constraint. In the second stage, given the contract, the director chooses his level of care. Finally, in the third stage the shareholders observe output from the project and decide whether to sue. Information is imperfect because at this third stage the shareholders only observe output, but not the level of care exerted by the director.

We look for a subgame perfect equilibrium of the game such that the vector $(z,\ \mu,\ \lambda)$ 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 we proceed backwards. First, we look at the litigation stage in order to characterize the shareholders' choice on whether to sue. Secondly, we study how the contract affects the director's choice of his level of care. Finally, we find the optimal contract by maximizing the value of the firm to its shareholders.[13]

3.6 Benchmarks

As a first benchmark consider first the case in which the director's level of care is observable and verifiable at no cost, i.e. $q_L = (1 - q_H) = 1$ and $K = 0$. If $\min\{w, D\}$ is sufficiently high ($\min\{w, D\} > c_H$) a contract such as $z \equiv (s = c_H, \alpha = 0, I = 0, \beta = 1)$ achieves the first best outcome. The director always exerts a high level of care $\mu = 1$, and upon observing a low return the shareholders always sue $\lambda = 1$. The director is left at his

[13] The normative perspective which we 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 (Branson, 1993; Easterbrook and Fishel, 1991).

reservation level of utility $U_d = w$, and the shareholders get all the surplus $U_s = (1 - p_H) - c_H - C$.

As a second benchmark consider the case in which the director's level of care is not observable and recourse to courts is not possible ($K = \infty$). Because of the moral hazard problem the portion of total surplus that the shareholders can appropriate is diminished by the fraction that for incentive reasons has to be allocated to the director. In order to induce the director to undertake a high level of care with positive probability, α must satisfy

$$\alpha(p_L - p_H) \geq c_H.$$

Even if we fix $s = 0$ and $\alpha = \frac{c_H}{p_L - p_H}$, the director's utility from choosing $\mu = 1$ exceeds his reservation level of utility w,

$$U_d = \frac{c_H}{p_L - p_H}(1 - p_H) - c_H + w = \frac{c_H(1 - p_L)}{p_L - p_H} + w > w.$$

And the shareholders' payoff is

$$U_s = \left(1 - \frac{c_H}{p_L - p_H}\right)(1 - p_H) - C.$$

Throughout the paper it will be assumed that

$$(1 - p_H) > \frac{c_H(1 - p_H)}{p_L - p_H} + C, \tag{3}$$

so this payoff is positive. This provides a lower bound on the shareholders' utility that can be achieved in the absence of a legal system. In what follows we analyze whether we can do better than this by introducing an imperfect and costly legal system.

4 Optimal protective measures

In this section we characterize the equilibrium of the game. First, we present the strategy spaces of the shareholders and the director and their payoff functions. Then, we characterize the shareholders' choice on whether to sue and the director's choice of his level of care, finding the set of Nash equilibria of the subgame that comprises the second and third stages of the game. We will prove that the introduction of protective measures expands the set of possible Nash equilibria. Next, we will find the optimal contract that induces each of these possible equilibria, showing how the features of the legal system determine the optimal division of the surplus between the shareholders and the director. Finally we find the subgame perfect equilibrium of the game maximizing the value of the firm over the set of possible equilibria. This will allow us to determine the circumstances under which the optimal contract includes protective measures.

Consider first the court's decision once the shareholders have decided to sue the director after observing a low return. The court observes y_H or y_L and declares the director guilty when the signal is low. At this stage the probability that a director that exerted a high (low) level of care c_H (c_L) is found guilty is q_H (q_L).

Now consider the decisions of the shareholders and the director once they have entered the contract. Recall that the strategy space of the shareholders is $A_s = \{P, N\}$, with $\lambda \in [0, 1]$ representing the probability that the shareholders proceed against the director, and the strategy space of the director is $A_d = \{c_H, c_L\}$, with $\mu \in [0, 1]$ representing the probability that the director exerts a high level of care. Then the payoff functions of the shareholders and the director are

$$\begin{aligned} U_s(z,\mu,\lambda) &= (1-\alpha)\left[\mu(1-p_H)+(1-\mu)(1-p_L)\right]-s-C \\ &\quad +\lambda\left[\mu p_H q_H+(1-\mu)p_L q_L\right]\min\{w,\beta D\} \\ &\quad -\lambda\left[\mu p_H+(1-\mu)p_L\right]K \end{aligned} \tag{4}$$

and

$$\begin{aligned} U_d(z,\mu,\lambda) &= \alpha\left[\mu(1-p_H)+(1-\mu)(1-p_L)\right]+s-\mu c_H+w \\ &\quad -\lambda\left[\mu p_H q_H+(1-\mu)p_L q_L\right]\min\{w,\beta D\}. \end{aligned} \tag{5}$$

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 expected damages award that can be obtained if the shareholders sue the director after observing 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 guilty times the amount that the director pays. The fifth and last 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 first and second terms in the directors' payoff function 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.

Notice that if the insurance market is competitive the shareholders can buy liability insurance at actuarially fair prices. This means that the price that the shareholders pay for the liability policy equals the amount that the insurance company expects to pay. This amount is equal to the probability that litigation occurs and a condemnatory sentence is passed times the percentage of the damages award to be paid by the insurance company, i.e.

$$\lambda \left[\mu p_H q_H + (1-\mu) p_L q_L\right](1-\beta)D.$$

Therefore this term is added and substracted from the payoff function of the shareholders leaving the function unchanged.

Notice also that protective measures do not alter the total surplus from the project, $U_s + (U_d - w)$, for given values of λ and μ. However the incentives for the shareholders to initiate legal proceedings and for the director to exert a high level of care, and the division of the surplus do change. We now derive the equilibrium strategies of the director and the shareholders in the game induced by a contract $z \equiv (s,\, \alpha,\, I,\, \beta)$.

Consider first the third stage. Upon observing a low return the shareholders 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 damages award, so they will sue with probability $\lambda > 0$ only if

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

Let $\overline{\mu}$ represent the value of μ that leaves the shareholders indifferent between their two possible strategies:

$$\overline{\mu} = \frac{q_L\left[\min\{w, \beta D\} + I(1-\beta)D\right] - K}{(q_L - q_H)\left[\min\{w, \beta D\} + I(1-\beta)D\right]}. \tag{6}$$

If $\mu > \overline{\mu}$ the shareholders will never sue, $\lambda = 0$. If $\mu < \overline{\mu}$ the shareholders will always sue, $\lambda = 1$. If $\mu = \overline{\mu}$ the shareholders may play a mixed strategy, $\lambda \in [0, 1]$.

Now we move to the second stage. The director's optimal strategy is to choose c_H with probability μ given that the shareholders sue with probability λ. Since the return of the project when no care is exerted ($\mu = 0$) is negative, we will restrict attention to the cases where $\mu \in (0, 1]$. This requires that the director's utility when he plays c_H be at least as high as his utility when he plays c_L:

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

Let $\overline{\lambda}$ represent the value of λ that leaves the director indifferent between his two possible strategies:

$$\overline{\lambda} = \frac{c_H - \alpha\left(p_L - p_H\right)}{\left(p_L q_L - p_H q_H\right)\min\{w, \beta D\}}. \tag{7}$$

If $\lambda > \overline{\lambda}$ the director will always choose a high level of care, $\mu = 1$. If $\lambda = \overline{\lambda}$ the director may play a mixed strategy, $\mu \in (0, 1]$.

We 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 have a strict preference for one of their actions, the equilibria where both players are indifferent about their actions, and the equilibria where one of the players has a strict preference while the other player is indifferent.

Consider first the equilibria (μ, λ) where both players have a strict preference. Since we are restricting attention to the cases where $\mu \in (0, 1]$ there are two possible pure strategies equilibria: $(\mu = 1, \lambda = 0)$ and $(\mu = 1, \lambda = 1)$. The equilibrium $(\mu = 1, \lambda = 0)$ requires that the director strictly prefers to exert a high level of care given that the shareholders never sue. Therefore it requires $\lambda = 0 > \overline{\lambda}$. Likewise it requires that the shareholders strictly prefer not to sue given that the director exerts a high level of care with probability one. Therefore it requires $\mu = 1 > \overline{\mu}$. The equilibrium $(\mu = 1, \lambda = 1)$ requires that the director strictly prefers to exert a high level of care given that the shareholders sue with probability one, i.e. $\lambda = 1 > \overline{\lambda}$, and that the shareholders strictly prefer to sue given that the director exerts a high level of care with probability one, i.e. $\mu = 1 < \overline{\mu}$.

Consider now the equilibria (μ, λ) in which both players are indifferent about their actions. These equilibria are possible only if given the contract z the shareholders are indifferent given that the director is also indifferent and vice versa. Therefore it requires $\mu = \overline{\mu}$ and $\lambda = \overline{\lambda}$.

Finally, we look at the equilibria in which one of the players has a strict preference, while the other player is indifferent. There are three possible cases. First, there are the equilibria where the shareholders have a strict preference for not suing and the director is indifferent $(\mu, 0)$. These equilibria require $\mu > \overline{\mu}$ and $\lambda = 0 = \overline{\lambda}$. Second, there are the equilibria where the shareholders have a strict preference for suing and the director is indifferent $(\mu, 1)$. These equilibria require $\mu < \overline{\mu}$ and $\lambda = 1 = \overline{\lambda}$. Finally, there are the equilibria where the director has a strict preference for exerting a high level of care while the shareholders are indifferent $(1, \lambda)$. These equilibria require

$\overline{\mu} = 1$ and $\lambda > \overline{\lambda}$.

Lemma 1 and Lemma 2 describe how the values of q_H, q_L, K and $\min\{w, D\}$ determine the set of Nash equilibria that obtain in the second and third stages of the game when protective measures are, respectively, not allowed and allowed.

Lemma 1: *When protective measures are not allowed* ($I = 0, \beta = 1$)*, the set* $N(z)$ *of Nash equilibria that can be induced by a contract* z *is such that:*

If $q_L \min\{w, D\} < K$*, the only equilibria that can be induced are equilibria with no litigation, i.e.*

$$N(z) = \left\{(\mu, 0)|\ \mu \in (0, 1] \textit{ if } \overline{\lambda} = 0 \textit{ and } \mu = 1 \textit{ if } \overline{\lambda} < 0\right\}.$$

If $q_H \min\{w, D\} \leq K \leq q_L \min\{w, D\}$*, there are no restrictions to the probability of litigation and, therefore, all the equilibria discussed above are possible.*

If $K < q_H \min\{w, D\}$ *the only equilibria that can be induced are equilibria where litigation always occurs, i.e.*

$$N(z) = \left\{(\mu, 1)|\ \mu \in (0, 1] \textit{ if } \overline{\lambda} = 1 \textit{ and } \mu = 1 \textit{ if } \overline{\lambda} < 1\right\}.$$

Proof: Substituting $I = 0$ and $\beta = 1$ into (6) gives

$$\overline{\mu} = \frac{q_L \min\{w, D\} - K}{(q_L - q_H) \min\{w, D\}}. \tag{8}$$

The result then follows immediately from the discussion of the three possible types of equilibria.

Remark: When legal uncertainty is high (q_H is close to q_L) both over and under-litigation may occur, because the shareholders may not be able to commit to their preferred litigation strategy. If $q_L \min\{w, D\} < K$ the expected damage award is low relative to legal costs. Then by (8) we have $\overline{\mu} < 0$, which implies that the shareholders' expected payoff from litigating is always negative. Therefore the only possible equilibria are equilibria with no litigation, i.e. $\lambda = 0$. Moreover the equilibrium must satisfy $\lambda = 0 \geq \overline{\lambda}$ in order to induce the director to exert care with positive probability. If $K < q_H \min\{w, D\}$ the expected damage award is high relative to legal costs. Then by (8) we have $\overline{\mu} > 1$, which implies that the expected payoff from litigating against an innocent director is strictly positive, so that the only possible equilibria are equilibria in which the shareholders always litigate, i.e. $\lambda = 1$. Again the equilibrium must satisfy $\lambda = 1 \geq \overline{\lambda}$ in order to induce the director to exert care with positive probability. Finally, consider the case where $q_H \min\{w, D\} \leq K \leq q_L \min\{w, D\}$. In this case by (8) we have $0 \leq \overline{\mu} \leq 1$. The shareholders will play $\lambda = 0$ ($\lambda = 1$) if the director chooses the action c_H with a probability $\mu > \overline{\mu}$ ($\mu < \overline{\mu}$), and will be indifferent between their two strategies if the director is also indifferent, i.e. if $\mu = \overline{\mu}$. Therefore all equilibria that satisfy $\lambda \geq \overline{\lambda}$ are possible.

Lemma 2: *When protective measures are allowed, the set of Nash equilibria $N(z)$ that can be induced by a contract z is such that:*

If $q_L D < K$, the only equilibria that can be induced are equilibria with no litigation, i.e.

$$N(z) = \left\{ (\mu, 0) |\ \mu \in (0, 1] \text{ if } \overline{\lambda} = 0 \text{ and } \mu = 1 \text{ if } \overline{\lambda} < 0 \right\}.$$

If $K \leq q_L D$, there are no restrictions to the probability of litigation and, therefore, all of the equilibria discussed above are possible.

Proof: When protective measures are allowed $\overline{\mu}$ is given by (6). Clearly, if $q_L D < K$, $\overline{\mu}$ is always smaller than zero. On the other hand, if $K \leq q_L D$, we can always set $\overline{\mu} \in (0, 1)$ by selecting the appropriate values of I and β.The result then follows immediately from the discussion of the three possible types of equilibria.

Remark: The introduction of protective measures alters the shareholders' ex-post incentives to litigate by increasing or decreasing the effective damages award that they will receive from the director and the insurance company. Therefore by introducing protective measures we expand the set of possible Nash equilibria. Equilibria with a positive probability of litigation ($\lambda > 0$) are possible even when the director's wealth w is too low to cover litigation expenses K, provided that the award for damages D is high enough and liability insurance is available. Additionally, over-litigation equilibria where the shareholders always choose $\lambda = 1$ can be avoided by introducing a limited liability provision or a cap for damages that reduces the expected penalty.

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 obtain in the second and third stages of the game between the director and the shareholders. We 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

$$\underset{z,\mu,\lambda}{Max}\, U_s(z,\mu,\lambda)$$

subject to

$$U_d(z,\mu,\lambda) \geq w, \tag{9}$$

$$(\mu,\lambda) \in N(z), \tag{10}$$

$$s \geq 0,\ 0 \leq \alpha \leq 1,\ I \in \{0,1\},\ \beta \in [0,1). \tag{11}$$

Condition (9) 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 we characterize the solution to this problem. We proceed in two steps. First we find the optimal contract $z^*(\mu,\lambda)$ that induces each of the possible equilibria

$$N \equiv \{(\mu,\lambda)|\ \exists\ z \text{ satisfying (9), (10) and (11)}\}.$$

Then we find a solution $z^*(\mu^*,\lambda^*)$ by maximizing the shareholders' payoff over the set N.

Lemma 3: *The optimal contract $z^*(\mu,\lambda)$ that implements an equilibrium $(\mu,\lambda)\in N$, is such that under this contract the director receives a control rent $U_d(z^*(\mu,\lambda),\mu,\lambda) - w$, equal to*

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

and the shareholders' utility is equal to

$$\begin{aligned} U_s(z^*(\mu,\lambda),\mu,\lambda) &= (1-p_H) - c_H - C - (U_d(z^*(\mu,\lambda),\mu,\lambda) - w) \\ &\quad -\lambda\left[\mu p_H + (1-\mu)p_L\right]K - (1-\mu)\left(p_L - p_H - c_H\right). \end{aligned}$$

Proof: See the Appendix.

Remark: When the level of care is not perfectly observable α must be sufficiently high in order to induce the director to undertake a high level of care. When the parties cannot make use of a legal system that punishes guilty directors this allows the director to get a positive control rent that decreases the returns to the shareholders. Now we can see how recourse to the legal system may alleviate this problem. When the probability of being taken to court λ is positive 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, because if he is found guilty he will have to pay $\min\{w, \beta D\}$.

The features of the legal system and the protective measures adopted (K and $\min\{w, \beta D\}$) determine the division of the surplus. On the one hand, litigation increases the shareholders' surplus because the control rent of the agent is reduced relative to the case where recourse to court is not possible ($K = \infty$). However, on the other hand, the shareholders' surplus decreases because of the costs of litigation that the shareholders incur $\lambda \left[\mu p_H + (1-\mu)p_L\right] K$, and also because in equilibrium the director may play a mixed strategy and this decreases total surplus from the project by $(1-\mu)(p_L - p_H - c_H)$. The relative importance of each of these effects will determine the optimal litigation strategy.

We can now characterize the solution $z^*(\mu^*, \lambda^*)$.

Proposition 1: *The optimal contract z^* is such that:*

(i) If $q_L D < K$, the director chooses the high level of care with probability one and the shareholders never litigate.

(ii) If $q_H \min\{w, D\} \leq K \leq q_L D$ there are two cases to consider de-

pending 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, for high values of* $\min\{w, D\}$*, when* $w < D$, *the optimal contract includes liability insurance* $(I^* = 1,\ \beta^* < 1)$.

(iii) If $K < q_H \min\{w, D\}$ *there are two cases to consider depending on the value of the maximum control rent 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 a positive probability (always litigate). Moreover, for low values of this control rent, the optimal contract includes a cap to damages* $(I^* = 0,\ \beta^* < 1)$.

Proof: See the Appendix.

Remark: The optimal contract depends, not only on the characteristics of the legal system (reflected in the parameters q_H, q_L, K and D) but also on the characteristics of the firm and the director (reflected in the parameters p_H, p_L, c_H and w). The protective measures allow the parties to introduce changes in the contract to adapt it to their particular characteristics so as to avoid both the over and the under-litigation equilibria. 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 et al. 1987).

The legal system will only be used if expected awards are high enough to give the shareholders' incentives to pay the legal costs. When $\min\{w, D\}$ is small relative to K, -or when q_H or $(1 - q_L)$ are high reflecting a high probability of legal errors- the shareholders will prefer not to litigate even when litigation is possible. This is because 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 on the shareholders' surplus being negative. When $\min\{w, D\}$ is high enough relative to K it is possible to induce an equilibrium with a positive probability of litigation $\lambda \in [0, 1]$ for $\mu = \overline{\mu}$. When $D > w$, we know by (6) that we can raise $\overline{\mu}$ by buying liability insurance. This induces the shareholders to litigate for higher values of μ, increasing the shareholders' payoff. When $\min\{w, D\}$ is very high relative to K, if no protective measures are introduced the shareholders will litigate with probability $\lambda = 1$. Introducing a cap to damages with $\beta = (K/q_H D)$ we can induce the shareholders to litigate with a lower probability without reducing $\overline{\mu} = 1$. But when K is small setting $\beta = (K/q_H D)$ reduces substantially the effective penalty that the director faces. Therefore when both $\min\{w, D\}$ and the value of the maximum control rent that the director can obtain are large relative to K, the shareholders will sue the director with probability one.

Up to now we have seen how the introduction of liability insurance and caps to the amount of damages increases the shareholders surplus, but there seems to be no role for LLPs. In this setting the only role for LLPs would be to allow the shareholders to avoid the over-litigation equilibrium where the shareholders always take the director to court. However a cap to the amount of damages also avoids over-litigation while at the same time allowing for a reduction in control rents.

Proposition 2 *When caps to 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 damages awards are so high as to induce over-litigation, i.e. when the following condition holds*

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

Proof: See the Appendix.

Remark: There is a trade-off between the control rent that the agent receives and the litigation cost that the shareholders incur. The adoption of LLPs can prevent over-litigation but it leaves the agent with a high control rent. Therefore the shareholders will adopt LLPs only when litigation costs are high compared with the control rent that the agent obtains. Since caps to damages are not allowed by the U.S. legal system, we would expect to observe the adoption of LLPs when damages awards are high (high D) and there is high legal uncertainty (q_H high), resulting in a high probability of litigation. Notice that this circumstances seem to correspond to the actual circumstances occurring when LLPs statutes where first introduced during the insurance crisis in the early 80's. This result is consistent with the empirical findings of Brook and Rao (1994) showing that the adoption of LLPs increases firm value. Notice also that firms that can reduce control rents through the use of alternative control mechanisms are more likely to adopt LLPs.

5 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. In this section we discuss the effects of settlement on the previous results.

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. In this section we study how the possibility of settlement affects the shareholders' incentives to litigate and the ex-ante value of the firm.

The model of out-of-court settlement presented in this section is adapted from two of the first papers on pretrial negotiation with private information: Bebchuk (1984) and P'ng (1987).[14] The model features one-sided incomplete information: the defendant has private knowledge on whether or not he was negligent and therefore about the outcome of the trial.

The settlement game starts after the shareholders decide to file a suit against the director. Then the settlement game proceeds as follows. First, the uninformed party, the shareholders, make a take-it-or-leave it settlement offer to the director.[15] Second, if the director accepts the settlement offer the shareholders do not incur legal costs. If the director rejects the offer then

[14]See also Spier (1992) and Nalebuff (1987).

[15]In the model presented here we assume a particular bargaining procedure: a take-it-or-leave it offer by the uninformed party, i.e. the shareholders. This procedure gives the shareholders a bargaining advantage since they will chose a settlement amount that is more favourable to them than the settlement amount that would be reached if we assumed different bargaining powers. The main point however is not to determine the settlement amount but the positive and negative effects that the possibility of settlement introduces in the game.

shareholders may i) drop the suit or ii) go to trial, incurring legal costs K.[16]

If the director and the shareholders reach an agreement to settle for an amount S, and the director is insured, with a co-insurance rate β, he will pay only a fraction βS.

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. This implies that the settlement offer must satisfy the following condition

$$(\beta + I(1-\beta))\, S \geq [\mu q_H + (1-\mu) q_L]\, [\min\{w, \beta D\} + I(1-\beta)D] - K. \quad (12)$$

And third, the director will not accept any settlement offer above his expected loss at trial.[17] Thus a necessary condition in order to induce a director of type i to settle is that the settlement offer S verifies

$$\beta S \leq q_i \min\{w, \beta D\}. \quad (13)$$

When these three necessary conditions are satisfied, once they have filled a lawsuit, the shareholders can do one of three things. They can decide not

[16] We consider a one-shot game. Spier (1992) considers a similar game in which there is a finite number of periods over which negotiation occurs. In this finite-horizon bargaining game in each period the defendant must either accept or reject the plaintiff's offer. If he rejects, the game continues with the plaintiff making another settlement offer in the following period. He shows than when delay is not inefficient (there is not a per period cost of bargaining, even if there is a discount factor) the party that makes the offers will prefer to wait until the last period to make the offer. Therefore the take-it-or-leave-it offer should be interpreted as the "last" offer.

[17] We consider the insurance company does not intervene in the settlement process. It can be shown that any settlement offer that is acceptable for the director is also acceptable for the insurance company.

to make any offer and proceed directly to court. Or, if they decide to make a settlement offer, they can either offer to settle for an amount

$$S_H \leq \frac{1}{\beta} q_H \min\{w, \beta D\},$$

that is acceptable both for the guilty and the innocent 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 for the guilty director.

If the shareholders proceed directly to court their expected payoff after suing is

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

If the shareholders offer to settle for S_H all cases will settle and the shareholders will get S_H. Therefore the settlement offer that maximizes the shareholders payoff is

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

If the shareholders offer to settle for S_L some cases will settle and some will go to trial.

Proposition 3 *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

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

(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

$$\rho = \frac{S_L}{q_L \left[\min\{w, \beta D\} + I(1-\beta)D\right]}.$$

Proof: See the Appendix.

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

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

With probability μ the director is innocent and he rejects the offer. The first term represents the loss that will be incurred if the shareholders take this innocent director to court with probability ρ. With probability $(1-\mu)$ the director is guilty. If the guilty director accepts the settlement offer (which happens with probability $(1-\delta)$) the shareholders get S_L. If the guilty 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 guilty director to court. Rearranging terms, the shareholders' expected utility after they make an offer to settle for S_L can be rewritten as

$$\frac{[(1-\mu)q_L+\mu q_H]\,[\min\{w,\beta D\}+I(1-\beta)D]-K}{q_L\,[\min\{w,\beta D\}+I(1-\beta)D]-K}\,(\beta+I(1-\beta))\,S_L, \quad (14)$$

which 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, 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. $\lambda=1$.

Knowing the way in which the settlement game will be played we can now determine the optimal contract of the game with settlement and protective measures. We look for a subgame perfect equilibrium of the game such that the vector (z,μ,λ,S_i) 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.

Now it is possible to characterize the equilibrium of the game that allows for out-of-court settlement following the same steps as in the previous section. The remainder of this section presents the results that show how settlement affects the adoption of protective measures and the division of surplus.[18]

Proposition 4: *The optimal contract $z^*(\mu^*,\lambda^*,S_j^*)$ is such that:*

[18]See the Appendix for a complete characterization of the equilibrium of the game that allows for out-of-court settlement.

(i) If $q_L D < K$, the director chooses the high level of care with probability one and the shareholders never litigate.

(ii) If $q_H D \leq K \leq q_L D$ there are three cases to consider depending on the value of $\min\{w, D\}$: For low values of $\min\{w, D\}$ the director chooses the high level of care with probability one and the shareholders never litigate. For intermediate (high) values of $\min\{w, D\}$ the director chooses the high level of care with probability lower than one, the shareholders always litigate and then make an offer to settle for S_L^* (S_H^*).

(iii) If $K < q_H D$ there are two cases to consider depending on the value of $\min\{w, D\}$: For low and high (intermediate) values of $\min\{w, D\}$ the director chooses the high level of care with probability one (lower than one), the shareholders always litigate and then make an offer to settle for S_H^* (S_L^*).

Moreover, in all the equilibria with litigation, when $w < D$, the optimal contract includes liability insurance $(I^* = 1,\ \beta^* < 1)$.

Proof: See the Appendix.

Remark: Depending on the value of $\min\{w, D\}$ the equilibria with litigation will settle for S_H^* or for S_L^*. The equilibria where all cases settle (i.e. the equilibria where the shareholders offer S_H^*) have lower litigation costs than the equilibria where some cases settle and some go to trial (i.e. the equilibria where the shareholders offer S_L^*) but, for a given value of $\min\{w, D\}$, the control rent that the director obtains is lower in the equilibria where the shareholders offer S_L^*. Also, for a given type of equilibria, the control rent of the director decreases as $\min\{w, D\}$ increases. When $\min\{w, D\}$ is very high or very low the difference in the amount of the control rent is lower than the difference in litigation costs and it is optimal to avoid going to trial, so all cases will settle for S_H^*.

The results regarding the use of liability insurance are maintained when we allow for out-of-court settlement. 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. Just like before when $K < q_H D$, if no protective measures are adopted $\overline{\mu} > 1$ and the only possible equilibria are equilibria where the shareholders always litigate $\lambda = 1$. But now, since we are assuming that settlement is costless, this does not result in over-litigation. An equilibrium with ($\mu = 1, \lambda = 1, S_j^* = S_H^*$) always gives the shareholders a higher payoff than an equilibrium with ($\mu = 1, \lambda = 0$). Thus, if settlement is costless, there is no role for the use of a cap to damages or LLPs.

We are also interested in the effect of settlement on the shareholders' surplus.

Proposition 5 *If the control rents are low settlement enhances the shareholders' surplus.*

Proof: See the Appendix.

Remark: Allowing for settlement has three effects. First, once the shareholders file a suit the expected litigation costs are lower if settlement is allowed. Second, the level of litigation increases when settlement is allowed because the shareholders' expected payoff from litigation is always positive. Therefore the effect of settlement on total litigation costs is ambiguous. Finally, settlement reduces the amount of control rents that can be extracted from the guilty defendant, because it allows him to pass for an innocent. Hence the total effect on the shareholders' surplus is ambiguous. When control rents are low (for example when there are alternative methods to reduce control rents) a legal regime that allows for settlement will be preferred.

6 Conclusions

The purpose of this paper 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 of the paper is that the simultaneous occurrence of very high damages awards and a widespread use of liability insurance and limited liability provisions that is currently observed in the US is optimal because it allows the shareholders to credibly commit to the ex-ante optimal suing strategy. When litigation is costly, the damages award has to be high enough to give the shareholders the incentives to litigate. However, when protective measures are not allowed, depending on the characteristics of the firm and the director (in particular the level of control rents that the director can obtain and his wealth) the same damages 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 only be maintained through the adoption of an insurance policy (that guarantees that the shareholders will receive the full amount of the damages award). When the director's wealth is high, a high damages award may induce the shareholders to litigate even if the probability that the director is guilty is very low, i.e. they will litigate too often. In this case the use of a cap to the damages (that reduces the damages award that the shareholders can obtain) can solve the problem. LLPs can also solve this problem but, given that they completely preclude legal actions, they will be adopted only if there are alternative mechanisms to reduce the director's control rent. These results suggests that the existing legal rules are designed to optimally fill the gaps in the contracts between shareholders and directors.

Some of the simplifying assumptions made in the model should be relaxed in further work. First, I have considered the case of one director in isolation. However the board of directors is, by definition, a collective body where each director is held liable for damages caused by collegiate decisions. It would therefore be interesting to study the effects of joint and several liability in this setting. Second, I have ruled out the possibility of a monitoring role for the insurance company. If the insurance company can exert some level of monitoring there may be additional gains for the shareholders from the availability of insurance. Third, I have assumed that the settlement process is costless. This implies that there cannot be over-litigation when settlement is allowed. However, being involved in a suit, even if the trial is avoided, may have substantial costs because it affects the reputation of the firm. If we introduce settlement costs $K' < K$ in the model, the threat of over-litigation will induce the shareholders to adopt LLPs for some values of the parameters. In particular, if control rents are low or they can be reduced through the use of alternative control mechanisms.

Appendix

Proof of Lemma 3: Consider a contract $z(\mu,\lambda)$ that implements an equilibrium (μ,λ). The contract must satisfy the individual rationality constraint. This implies:

$$\alpha \geq \alpha_{IR} = \frac{\mu c_H + \lambda\left[\mu p_H q_H + (1-\mu) p_L q_L\right]\min\{w,\beta D\} - s}{\mu\left(1-p_H\right) + \left(1-\mu\right)\left(1-p_L\right)}. \tag{15}$$

In order to induce an equilibrium (μ,λ) with $\mu \in (0,1]$ the contract must be such that the director's payoff when he plays c_H be at least as high as his payoff when he plays c_L. This implies:

$$\alpha \geq \alpha_{IC} = \frac{c_H - \lambda\left(p_L q_L - p_H q_H\right)\min\{w,\beta D\}}{p_L - p_H}. \tag{16}$$

Lemma 4 shows that for given values of $\overline{\mu}$, μ and λ $I^*(\mu,\lambda)$ and $\beta^*(\mu,\lambda)$ do not depend on α or s. Therefore the shareholders' payoff, stated in (4), is decreasing in α and s. This implies that, provided that (15) is satisfied, the optimal contract $z^*(\mu,\lambda)$ will satisfy (16) with equality and vice versa. There are two cases to study depending on the value of λ :

(i) If $\lambda \geq \frac{c_H}{(p_L q_L - p_H q_H)\min\{w,\beta D\}}$,we know that $\alpha_{IC} \leq 0$, therefore (16) is satisfied for any $\alpha \geq \alpha_{IR} \geq 0$, and the optimal contract $z^*(\mu,\lambda)$ will be such that α and s are positive and satisfy (15) with equality

$$\alpha^* = \alpha_{IR} = \frac{\mu c_H + \lambda\left[\mu p_H q_H + (1-\mu) p_L q_L\right]\min\{w,\beta^* D\} - s^*}{\mu\left(1-p_H\right) + \left(1-\mu\right)\left(1-p_L\right)} \geq \alpha_{IC}.$$

(ii) If $\lambda < \frac{c_H}{(p_L q_L - p_H q_H)\min\{w,\beta D\}}$, we know that $\alpha_{IC} \geq \alpha_{IR}$ for $s \geq \overline{s}$

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

and $\alpha_{IR} > \alpha_{IC}$ for $s < \overline{s}$. Therefore the optimal contract $z^*(\mu,\lambda)$ has $s^* = \overline{s}$, and

$$\alpha^* = \alpha_{IC} = \frac{c_H - \lambda\left(p_L q_L - p_H q_H\right)\min\{w, \beta D\}}{p_L - p_H} \geq \alpha_{IR}.$$

In both cases direct substitution of the values α^* and s^* in equations (4) and (5) shows that $U_d(z^*(\mu,\lambda),\mu,\lambda) - w$ is equal to

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

and that the shareholders' utility is equal to

$$\begin{aligned} U_s(z^*(\mu,\lambda),\mu,\lambda) &= (1-p_H) - c_H - C - (U_d(z^*(\mu,\lambda),\mu,\lambda) - w) \\ &\quad -\lambda\left[\mu p_H + (1-\mu)p_L\right]K - (1-\mu)\left(p_L - p_H - c_H\right). \end{aligned}$$

This completes the proof.

Lemma 4: *The only equilibria (μ,λ) that can be induced are equilibria such that*

$$\overline{\mu} \leq \frac{q_L D - K}{(q_L - q_H)D}.$$

Moreover, given $\overline{\mu}$, the optimal contract $z^*(\mu,\lambda)$ that induces an equilibrium (μ,λ) includes: (i) liability insurance

$$\left(I^*(\mu,\lambda) = 1,\ \beta^*(\mu,\lambda) = \frac{w}{D} + 1 - \frac{K}{\left[q_L - (q_L - q_H)\overline{\mu}\right]D}\right),$$

when

$$\overline{\mu} > \frac{q_L w - K}{(q_L - q_H)w},$$

and (ii) a cap to damages

$$\left(I^*(\mu,\lambda) = 0,\ \beta^*(\mu,\lambda) = \frac{K}{\left[q_L - (q_L - q_H)\overline{\mu}\right]D}\right),$$

when

$$\overline{\mu} \leq \frac{q_L w - K}{(q_L - q_H)w}.$$

Proof of Lemma 4: We know by (6) that $\overline{\mu}$ increases with increases in the amount of the award that the shareholders receive $(\min\{w, \beta D\} + I(1-\beta)D)$. Given that $I \in \{0, 1\}$ and $\beta \in [0, 1)$, we know that

$$D \geq \min\{w, \beta D\} + I(1-\beta)D.$$

Therefore it is impossible to induce an equilibrium (μ, λ) such that

$$\overline{\mu} > \frac{q_L D - K}{(q_L - q_H)D}.$$

For smaller values of $\overline{\mu}$ it is always possible to find values of I and β that satisfy (6). Rearranging (6) we find that, given $\overline{\mu}$, in order to implement an equilibrium (μ, λ) the values of I and β must be such that

$$\min\{w, \beta D\} + I(1-\beta)D = \frac{K}{q_L - (q_L - q_H)\overline{\mu}}. \tag{17}$$

By Lemma 3 we know that the shareholders' payoff under the optimal contract $z^*(\mu, \lambda)$ that induces an equilibrium (μ, λ) is non decreasing in $\min\{w, \beta(\mu, \lambda)D\}$. Therefore, given $\overline{\mu}$, the optimal values $I^*(\mu, \lambda)$ and $\beta^*(\mu, \lambda)$ are found maximizing $\min\{w, \beta(\mu, \lambda)D\}$ subject to condition (17). This problem has two different solutions depending on the value of $\overline{\mu}$. First, for values of $\overline{\mu}$, such that

$$\frac{q_L w - K}{(q_L - q_H)w} < \overline{\mu} \leq \frac{q_L D - K}{(q_L - q_H)D},$$

the solution is

$$\left(I^*(\mu, \lambda) = 1,\ \beta^*(\mu, \lambda) = \frac{w}{D} + 1 - \frac{K}{\left[q_L - (q_L - q_H)\overline{\mu}\right] D} \right),$$

and then $\min\{w, \beta^*(\mu, \lambda)D\} = w = \min\{w, D\}$. Second for values of $\overline{\mu}$ such that

$$\overline{\mu} \leq \frac{q_L \min\{w, D\} - K}{(q_L - q_H) \min\{w, D\}},$$

the solution is

$$\left(I^*(\mu, \lambda) = 0,\ \beta^*(\mu, \lambda) = \frac{K}{[q_L - (q_L - q_H)\overline{\mu}]\, D} \right),$$

and then $\min\{w, \beta^*(\mu, \lambda)D\} = \frac{K}{[q_L - (q_L - q_H)\overline{\mu}]} \leq \min\{w, D\}$.

This completes the proof.

Lemma 5: *We can find a solution* $(z^*(\mu^*, \lambda^*), \mu^*, \lambda^*)$ *by maximizing the shareholders' payoff over the set* N'

$$N' \equiv \left\{(\mu{=}1,\ \lambda{=}0);(\mu{=}1,\ \lambda{=}1);(\mu{=}\overline{\mu},\ \lambda{=}\overline{\lambda})\right\},$$

with $\overline{\mu} = \min\{1, \frac{q_L D - K}{(q_L - q_H)D}\}$ *and*

$$\overline{\lambda} = \widehat{\lambda} = \min\left\{1, \frac{(1 - p_L)c_H}{[(1 - p_H)p_L q_L - (1 - p_L)p_H q_H] \min\{w, \beta^* D\}}\right\}.$$

Proof of Lemma 5: We will first prove that the equilibria in which one of the players has a strict preference, while the other player is indifferent do not maximize the shareholders' payoff. There are three possible cases. First, the equilibria $(\mu, 0)$ that require $\mu > \overline{\mu}$ and $\lambda = 0 = \overline{\lambda}$. Second, the equilibria $(\mu, 1)$ that require $\mu \leq \overline{\mu}$ and $\overline{\lambda} = 1$. Third, the equilibria $(1, \lambda)$ that require $\overline{\mu} = 1$ and $\lambda \geq \overline{\lambda}$.

By Lemma 4 we know that $\beta^*(\mu, \lambda)$ depends only on $\overline{\mu}$, not on (μ, λ). This implies that the shareholders' payoff under the optimal contract $z^*(\mu, \lambda)$ that induces an equilibrium (μ, λ) is increasing in μ

$$\frac{\delta U_s(z^*(\mu, \lambda), \mu, \lambda)}{\delta \mu} = \lambda\, [p_L - p_H]\, K + (p_L - p_H - c_H) > 0.$$

This, in turn, implies that we can discard our first and second types of equilibria because

$$U_s(z^*(1,0),1,0) \geq U_s(z^*(\mu,0),\mu,0), \qquad \forall\mu > \overline{\mu},$$

$$U_s(z^*(\overline{\mu},\overline{\lambda}),\overline{\mu},\overline{\lambda}) \geq U_s(z^*(\mu,\overline{\lambda}),\mu,\overline{\lambda}), \qquad \forall\mu \leq \overline{\mu}.$$

Finally consider the equilibria $(1,\lambda)$. These equilibria require $\overline{\mu} = 1$ and $\lambda \geq \overline{\lambda}$. The shareholders' payoff is

$$U_s(z(\overline{\mu}=1,\lambda),\overline{\mu}=1,\lambda) = (1-\alpha)(1-p_H)-s-C+\lambda p_H\left[q_H \min\{w,\beta D\}-K\right]$$

Since $\overline{\mu} = 1$ we know by (6) that the last term in this expression is negative. We know by (7) that the optimal contract $z^*(\overline{\mu} = 1, \lambda > \overline{\lambda})$ that implements the equilibrium $(\overline{\mu} = 1, \lambda > \overline{\lambda})$, can also implement the equilibrium $(\overline{\mu} = 1, \overline{\lambda})$. This implies that we can also discard our third type of equilibria because

$$U_s(z^*(\overline{\mu}=1,\overline{\lambda}),\overline{\mu}=1,\overline{\lambda}) \geq U_s(z^*(\overline{\mu}=1,\lambda),\overline{\mu}=1,\lambda), \qquad \forall\lambda > \overline{\lambda}.$$

This leaves us with the set

$$N' \equiv \left\{(\mu{=}1,\ \lambda{=}0);(\mu{=}1,\ \lambda{=}1);(\mu{=}\overline{\mu},\ \lambda{=}\overline{\lambda})\right\}.$$

Consider now the mixed strategies equilibria $(\mu{=}\overline{\mu},\ \lambda{=}\overline{\lambda})$. We already know that the shareholders' payoff is increasing in μ. Therefore we can discard equilibria $(\overline{\mu},\overline{\lambda})$ with $\overline{\mu} < \min\{1, \frac{q_L D-K}{(q_L-q_H)D}\}$. Let $\widehat{\lambda}$ denote the value of λ that satisfies the following

$$\widehat{\lambda} = \min\left\{1, \frac{(1-p_L)c_H}{[(1-p_H)p_L q_L-(1-p_L)p_H q_H]\min\{w,\beta^* D\}}\right\}.$$

Clearly, the shareholders' utility is decreasing in $\overline{\lambda}$ for values of $\overline{\lambda}$ higher than $\widehat{\lambda}$

$$\frac{\delta U_s(z^*(\overline{\mu},\overline{\lambda}),\overline{\mu},\overline{\lambda})}{\delta\overline{\lambda}}\mid_{\overline{\lambda}\geq\widehat{\lambda}} = -\left[\overline{\mu}p_H+(1-\overline{\mu})p_L\right]K<0.$$

For smaller values of $\overline{\lambda}$ the shareholders' payoff may be decreasing or increasing in $\overline{\lambda}$

$$\frac{\delta U_s(z^*(\overline{\mu},\overline{\lambda}),\overline{\mu},\overline{\lambda})}{\delta\overline{\lambda}}\mid_{\overline{\lambda}<\widehat{\lambda}} =$$

$$\frac{\left[(1-p_H)p_Lq_L-(1-p_L)p_Hq_H\right]\min\{w,\beta^*(\overline{\mu},\overline{\lambda})D\}}{p_L-p_H}-\left[\overline{\mu}p_H+(1-\overline{\mu})p_L\right]K\lesseqgtr 0$$

If the shareholders' payoff is decreasing in $\overline{\lambda}$ for $\overline{\lambda}<\widehat{\lambda}$ we know that

$$U_s(z^*(1,0),1,0)\geq U_s(z^*(\overline{\mu},\overline{\lambda}=0),\overline{\mu},\overline{\lambda}=0)\geq U_s(z^*(\overline{\mu},\overline{\lambda}),\overline{\mu},\overline{\lambda}).$$

If the shareholders' payoff is increasing in $\overline{\lambda}$ for $\overline{\lambda}<\widehat{\lambda}$ then

$$U_s(z^*(\overline{\mu},\widehat{\lambda}),\overline{\mu},\widehat{\lambda})\geq U_s(z^*(\overline{\mu},\overline{\lambda}),\overline{\mu},\overline{\lambda}).$$

Therefore if the optimal contract induces an equilibrium in mixed strategies $(\mu=\overline{\mu},\lambda=\overline{\lambda})$, this equilibrium will have $\overline{\lambda}=\widehat{\lambda}$.

This completes the proof.

Proof of Proposition 1: To prove Proposition 1 we will make use of the Lemmas 1, 2 and 3, from Section 4 and of the Lemmas 4 and 5 stated above.

We know by Lemma 5 that we can find a solution $(z^*(\mu^*,\lambda^*),\mu^*,\lambda^*)$ by maximizing the shareholders' payoff over the set N'. There are three different cases to consider:

(i) When $q_LD<K$ we know by Lemma 2 that the only possible equilibrium is $(\mu=1,\lambda=0)$. In this case the introduction of protective measures can not alter the shareholders' surplus because litigation is not possible.

(ii) When $q_H \min\{w, D\} < K \leq q_L D$ both $(\mu = \overline{\mu}, \lambda = \overline{\lambda})$ and $(\mu{=}1,\ \lambda{=}0)$ are possible and then

$U_s(z^*(\overline{\mu}, \widehat{\lambda}), \overline{\mu}, \widehat{\lambda}) - U_s(z^*(1,0), 1, 0) =$

$$\frac{(1-p_L)c_H}{p_L - p_H} - \widehat{\lambda}\left[\overline{\mu}p_H + (1-\overline{\mu})p_L\right]K - (1-\overline{\mu})\left(p_L - p_H - c_H\right)$$
$$- \max\left\{0, \frac{(1-p_L)c_H - \left[(1-p_H)p_L q_L - (1-p_L)p_H q_H\right]\min\{w, \beta^* D\}}{p_L - p_H}\right\}.$$

Using Lemma 4 we can compute $\beta^*(\overline{\mu}, \widehat{\lambda})$ for $\overline{\mu}{=}\min\{1, \frac{q_L D - K}{(q_L - q_H)D}\}$. Simple computations show that when $q_H \min\{w, D\} < K$ this β^* is such that

$$\min\{w, \beta^* D\} = \min\{w, D\}.$$

Thus, the difference $U_s(z^*(\overline{\mu}, \widehat{\lambda}), \overline{\mu}, \widehat{\lambda}) - U_s(z^*(1,0), 1, 0)$ increases as $\min\{w, D\}$ increases. In particular if $\min\{w, D\} = \frac{K}{q_H}$, we have $\overline{\mu} = 1$. Then this difference is equal to

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

which is strictly positive. For higher values of $\min\{w, D\}$, $U_s(z^*(\overline{\mu}, \widehat{\lambda}), \overline{\mu}, \widehat{\lambda})$ is higher than $U_s(z^*(1,0), 1, 0)$.

(iii) When $K < q_H \min\{w, D\}$ the three equilibria in N' are possible but we know that $U_s(z^*(\overline{\mu}, \widehat{\lambda}), \overline{\mu}, \widehat{\lambda})$ is higher than $U_s(z^*(1,0), 1, 0)$. Therefore we only have to compare the equilibrium $(\mu = \overline{\mu}, \lambda = \overline{\lambda})$ with the equilibrium $(\mu{=}1,\ \lambda{=}1)$. In this case $\overline{\mu}{=}\min\{1, \frac{q_L D - K}{(q_L - q_H)D}\} = 1$. Using Lemma

4 we can compute $\beta^*(\overline{\mu}, \widehat{\lambda})$ for $\overline{\mu}$=1. Simple computations show that when $K < q_H \min\{w, D\}$ this β^* is such that

$$\min\{w, \beta^* D\} = \frac{K}{q_H}.$$

Thus, the difference in the shareholders' utility is

$$U_s(z^*(\overline{\mu} = 1, \widehat{\lambda}), \overline{\mu} = 1, \widehat{\lambda}) - U_s(z^*(1,1), 1, 1) = \left(1 - \widehat{\lambda}\right) p_H K +$$

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

This difference is positive if and only if

$$K \geq \frac{q_H(1-p_L)c_H}{(1-p_H)p_L q_L - (1-p_L)p_H q_H}.$$

This completes the proof.

Proof of Proposition 2: We know by Lemma 5 that we can find a solution $(z^*(\mu^*, \lambda^*), \mu^*, \lambda^*)$ by maximizing the shareholders' payoff over the set N'. When $K < q_H \min\{w, D\}$ we know by Proposition 1 that the implementation of the mixed strategies equilibrium $(\overline{\mu}, \widehat{\lambda})$ requires the use of a cap to damages. When caps to damages are not allowed the only possible equilibria are (μ=1, λ=1) and, when LLPs are allowed, $(\mu = 1, \lambda = 0)$. The difference in the shareholders' utility is

$$U_s(z^*(1,0), 1, 0) - U_s(z^*(1,1), 1, 1) = -\frac{(1-p_L)c_H}{p_L - p_H} + p_H K +$$

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

which is positive if and only if

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

This completes the proof.

Proof of Proposition 3: Consider the decision of the shareholders after a settlement offer S_L is rejected. They know that according to the stated strategies for the director the probability that the director is innocent given that he has rejected the offer is

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

Hence 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 will be indifferent between going to trial and dropping the action if expected payoff from going to trial is zero, i.e. if and only if

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

Next, consider the decision of the director. If he chose c_H he will never settle for S_L because he is better off going to trial. If he chose c_L then, given that the shareholders will go to trial with probability ρ, his expected payoff if he does not accept the offer is

$$-\rho q_L \min\{w, \beta D\}.$$

Therefore he is indifferent between accepting or rejecting an offer to settle for S_L if

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

This completes the proof.

6.1 Results of the game that allows for out-of-court settlement

Let S_j^* denote the settlement offer that the shareholders make in the equilibrium ($j = 0, H, L$), with $S_0^* > S_j^*$. Making an offer S_0^* 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 $\delta_{i0} = 1$, $\delta_{iH} = 0$ and $\rho_0 = \rho_H = 1$. Finally let μ_i demote 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 allows for out-of-court settlement can be rewritten as

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

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

Now it is possible to characterize the equilibrium of the game that allows for out-of-court settlement following the same steps as in the previous section.

Consider first the last stage of the game that starts after the shareholders have filed a suit against the director. After suing 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 highests payoff once a suit has been filed. Comparing the shareholders' expected utility in each of the three possible cases we can see that 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 shreholders' expected payoff is equal when they offer S_H^* and when they offer S_0^* and S_L^* respectively:

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

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

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

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

and S_0^* if and only if this last condition does not hold. In what follows, to make the model tractable, I will assume that this condition holds, so that whenever settlement is possible the parties will try to settle. It can be checked that in equilibrium this condition holds. Notice that when this condition holds $\overline{\mu} > \mu_{HL} > \mu_{H0}$.

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

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

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 $\lambda = \overline{\lambda}$:

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

And $\mu = 1$ if $\lambda > \overline{\lambda}$.

We define $N^S(z)$ as the set of Nash equilibria of the subgame that comprises the second and third stages of the game. The set $N^S(z)$ may have two different types of equilibria: the equilibria where both players have a strict preference for one of their actions and the equilibria where one of the players has a strict preference while the other player is indifferent.

Consider first the equilibria (μ, λ) where both players have a strict preference. Since we are restricting attention to the cases where $\mu \in (0, 1]$ there are two possible pure strategies equilibria: $(\mu = 1, \lambda = 0)$, and $(\mu = 1, \lambda = 1, S_H^*)$. The equilibrium $(\mu = 1, \lambda = 0)$ requires that the director strictly prefers to exert a high level of care given that the shareholders never sue. Therefore it requires $\lambda = 0 > \overline{\lambda}$. Likewise it requires that the shareholders strictly prefer not to sue given that the director exerts a high level of care with probability one. Therefore it requires $\mu = 1 > \overline{\mu}$. The equilibrium $(\mu = 1, \lambda = 1, S_H^*)$ requires that the director strictly prefers to exert a high level of care given that the shareholders sue with probability one and offer to settle for S_H^*, i.e. $\lambda = 1 > \overline{\lambda}$, that the shareholders strictly prefer to sue given that the director exerts a high level of care with probability one, i.e. $\mu = 1 < \overline{\mu}$, and that, after suing, the shareholders prefer to settle for S_H^* given that the director exerts a high level of care with probability one, i.e. $\mu = 1 > \mu_{HL}$.

Consider now the equilibria in which one of the players has a strict preference, while the other player is indifferent. There are three possible cases. First there are the equilibria where the shareholders have a strict preference for not suing and the director is indifferent $(\mu, 0)$. These equilibria require $\mu > \overline{\mu}$ and $\lambda = 0 = \overline{\lambda}$. Second, there are the equilibria where the shareholders have a strict preference for suing and offering S_H^* and the director is indifferent $(\mu, 1, S_H^*)$. These equilibria require $\mu_{HL} < \mu \leq \overline{\mu}$ and $\lambda = 1 = \overline{\lambda}$. Third, there are the equilibria where the shareholders have a strict preference for suing and offering S_L^* and the director is indifferent $(\mu, 1, S_L^*)$. These equilibria require $\mu \leq \mu_{HL} < \overline{\mu}$ and $\lambda = 1 = \overline{\lambda}$.

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

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

Lemma 1.S: *When protective measures are not allowed $(I = 0, \beta = 1)$, the set $N^S(z)$ of Nash equilibria that can be induced by a contract z is such that:*

If $q_L \min\{w, D\} < K$, the only equilibria that can be induced are equilibria with no litigation, i.e.

$$N^S(z) = \left\{(\mu, 0)|\ \mu \in (0,1] \textit{ if } \overline{\lambda} = 0 \textit{ and } \mu = 1 \textit{ if } \overline{\lambda} < 0\right\}.$$

If $q_H \min\{w, D\} \leq K \leq q_L \min\{w, D\}$, *there are no restrictions to the probability of litigation and, therefore, all of the equilibria discussed above are possible.*

If $K < q_H \min\{w, D\}$ *the only equilibria that can be induced are equilibria where litigation always occurs, i.e.*

$$N^S(z) = \begin{cases} (\mu, 1, S_H^*)|\ \mu \in (\mu_{HL}, \min\{1, \overline{\mu}\}] \ \textit{and}\ \overline{\lambda} = 1, \\ (\mu, 1, S_L^*)|\ \mu \in (0, \mu_{HL}] \ \textit{and}\ \overline{\lambda} = 1. \end{cases}$$

Proof of Lemma 1.S: Substituting $I = 0$ and $\beta = 1$ into (6) gives

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

The result then follows immediately from the discussion of the three possible types of equilibria.

Lemma 2.S: *When protective measures are allowed, the set of Nash equilibria* $N^S(z)$ *that can be induced by a contract* z *is such that:*

If $q_L D < K$, *the only equilibria that can be induced are equilibria with no litigation, i.e.*

$$N^S(z) = \left\{(\mu, 0)|\ \mu \in (0, 1]\ \textit{if}\ \overline{\lambda} = 0\ \textit{and}\ \mu = 1\ \textit{if}\ \overline{\lambda} < 0\right\}.$$

If $K \leq q_L D$, *there are no restrictions to the probability of litigation and, therefore, all of the equilibria discussed above are possible.*

Proof of Lemma 2.S: When protective measures are allowed (6) implies

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

Then if $q_L D < K$, $\overline{\mu}$ is always smaller than zero. If $K \leq q_L D$, we can always set $\overline{\mu} \in (0,1)$ selecting the adequate values of I and β. The result then follows immediately from the discussion of the three possible types of equilibria.

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

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

subject to

$$U_d(z,\mu,\lambda,S_j^*) \geq w, \tag{18}$$

$$(\mu,\lambda,S_j^*) \in N^S(z), \tag{19}$$

$$s \geq 0,\ 0 \leq \alpha \leq 1,\ I \in \{0,1\},\ \beta \in [0,1). \tag{20}$$

Condition (18) guarantees that the contract satisfies the director's individual rationality constraint. Since $N^S(z)$ is the set of Nash equilibria of the subgame that comprises the second and third and fourth stages of the game, it follows that a solution $(z^*,\mu^*,\lambda^*,S_j^*)$ to this problem is a subgame perfect equilibrium of the game.

To characterize the solution to this problem we proceed in two steps. First we find the optimal contract $z^*(\mu,\lambda,S_j^*)$ that induces each of the possible equilibria

$$N^S \equiv \left\{(\mu,\lambda,S_j^*)|\ \exists\ z \text{ satisfying (18), (19) and (20)}\right\}.$$

Then we find a solution $z^*(\mu^*,\lambda^*,S_j^*)$ by maximizing the shareholders' payoff over the set N^S.

Lemma 3.S: *The optimal contract* $z^*(\mu, \lambda, S_j^*)$ *that implements an equilibrium* $(\mu, \lambda, S_j^*) \in N^S$*, is such that under this contract the director receives a control rent* $U_d(z^*, \mu, \lambda, S_j^*) - w$ *equal to*

$$\max\left\{0, \frac{(1-p_L)c_H - \lambda \min\{w, \beta^* D\} M}{p_L - p_H}\right\},$$

$$M = (1-p_H)p_L\left[\delta_{Lj}\rho_j q_L + (1-\delta_{Lj})q_j\right] - (1-p_L)p_H\left[\delta_{Hj}\rho_j q_H + (1-\delta_{Hj})q_j\right],$$

and the shareholders' utility is equal to

$$\begin{aligned} U_s(z^*, \mu, \lambda, S_j^*) &= (1-p_H) - c_H - C - \left(U_d(z^*, \mu, \lambda, S_j^*) - w\right) \\ &\quad -\lambda \sum_{i=H,L} \mu_i p_i \left[\delta_{ij}\rho_j K\right] - (1-\mu)(p_L - p_H - c_H). \end{aligned}$$

Proof of Lemma 3.S: The proof follows the same reasoning as the proof of Proposition 3.

Lemma 4.S: *The only equilibria* (μ, λ, S_j^*) *that can be induced are equilibria such that*

$$\overline{\mu} \leq \frac{q_L D - K}{(q_L - q_H) D}.$$

Moreover, given $\overline{\mu}$*, the optimal contract* $z^*(\mu, \lambda, S_j^*)$ *that induces an equilibrium* (μ, λ, S_j^*) *includes: (i) liability insurance*

$$\left(I^*(\mu, \lambda, S_j^*) = 1,\ \beta^*(\mu, \lambda, S_j^*) = \frac{w}{D} + 1 - \frac{K}{\left[q_L - (q_L - q_H)\overline{\mu}\right] D}\right),$$

when

$$\overline{\mu} > \frac{q_L w - K}{(q_L - q_H) w},$$

and (ii) a cap to damages

$$\left(I^*(\mu, \lambda, S_j^*) = 0,\ \beta^*(\mu, \lambda, S_j^*) = \frac{K}{\left[q_L - (q_L - q_H)\overline{\mu}\right] D}\right),$$

when

$$\overline{\mu} \leq \frac{q_L w - K}{(q_L - q_H)w}.$$

Proof of Lemma 4.S: The proof follows the same reasoning as the proof of Lemma 4.

Lemma 5.S: *We can find a solution* $(z^*, \mu^*, \lambda^*, S_j^*)$ *by maximizing the shareholders' payoff over the set* $N^{S'}$

$$N^{S'} \equiv \{(\mu{=}1,\ \lambda{=}0);(\mu{=}\min\{1,\overline{\mu}\},\ \lambda{=}1{,}S_H^*);(\mu{=}\mu_{HL},\ \lambda{=}1,S_L^*)\},$$

with $\overline{\mu} = \frac{q_L D - K}{(q_L - q_H)D}$ *and* $\mu_{HL} = \frac{q_L D - K}{q_L D}$.

Proof of Lemma 5.S: We will first prove that the rest of the feasible equilibria do not maximize the shareholders' payoff. Consider first the equilibria with no litigation, i.e. the equilibria $(\mu, 0)$ with $\mu \in (0, 1]$. We know by Lemma 3.S that the shareholders' payoff under the optimal contract $z^*(\mu, 0)$ that induces such an equilibrium is

$$U_s(z^*, \mu, 0) = (1 - p_H) - c_H - C - \frac{(1 - p_L)c_H}{p_L - p_H} - (1 - \mu)(p_L - p_H - c_H),$$

which is increasing in μ. Therefore we can discard all the other equilibria with no litigation because

$$U_s(z^*, 1, 0) \geq U_s(z^*, \mu, 0), \qquad \forall \mu > \overline{\mu}.$$

Consider secondly the equilibria with litigation where after initiating legal proceedings the shareholders always settle, i.e. the equilibria $(\mu, 1, S_H^*)$ with $\mu \in (\mu_{HL}, \min\{1, \overline{\mu}\}]$ and $\overline{\lambda} = 1$. We know by Lemma 3.s that the shareholders' payoff under the optimal contract $z^*(\mu, 1, S_H^*)$ that induces such an equilibrium is

$$U_s(z^*,\mu,1,S_H^*) = (1-p_H)-c_H-C-(1-\mu)\,(p_L-p_H-c_H)$$
$$-\max\left\{0,\frac{(1-p_L)c_H-\min\{w,\beta^* D\}\,(p_L-p_H)\,q_H}{p_L-p_H}\right\}.$$

By Lemma 4.S we know that $\beta^*(\mu,\lambda)$ depends only on $\overline{\mu}$, not on (μ,λ). This implies that the shareholders' payoff is increasing in μ and that

$$U_s(z^*,\min\{1,\overline{\mu}\},1,S_H^*) > U_s(z^*,\mu,1,S_H^*), \qquad \forall \mu < \min\{1,\overline{\mu}\}.$$

Finally, consider the equilibria with litigation where after initiating legal proceedings the shareholders make a high settlement offer S_L^*, i.e. the equilibria $(\mu,1,S_L^*)$ with $\mu \in (0,\mu_{HL}]$ and $\overline{\lambda}=1$. We know by Lemma 3.S that the shareholders' payoff under the optimal contract $z^*(\mu,1,S_L^*)$ that induces such an equilibrium is

$$U_s(z^*,\mu,1,S_L^*) = (1-p_H)-c_H-C-(1-\mu)\,(p_L-p_H-c_H)$$
$$-\max\left\{0,\frac{(1-p_L)c_H-\min\{w,\beta^* D\}\,[(1-p_H)p_Lq_L-(1-p_L)p_Hq_H]}{p_L-p_H}\right\}$$
$$-\mu K\left(p_H+p_L\frac{K-q_H\,[\min\{w,\beta^* D\}+I(1-\beta^*)D]}{q_L\,[\min\{w,\beta^* D\}+I(1-\beta^*)D]-K}\right).$$

By Lemma 4.S we know that $\beta^*(\mu,\lambda)$ depends only on $\overline{\mu}$, not on (μ,λ). Therefore

$$\frac{\delta U_s(z^*,\mu,1,S_L^*)}{\delta\mu} = (p_L-p_H-c_H)$$
$$-K\left(p_H+p_L\frac{K-q_H\,[\min\{w,\beta^* D\}+I(1-\beta^*)D]}{q_L\,[\min\{w,\beta^* D\}+I(1-\beta^*)D]-K}\right)\lesseqgtr 0.$$

If this derivative is negative it is optimum to set $\mu = 0$. But if $\mu = 0$ the project is not feasible. Therefore a necessary condition for the equilibrium $(\mu, 1, S_L^*)$ to maximize shareholders' payoff is that the sign of this derivative is positive. And when this is the case

$$U_s(z^*, \mu_{HL}, 1, S_L^*) > U_s(z^*(\mu, 1, S_L^*), \mu, 1, S_L^*), \qquad \forall \mu < \mu_{HL}.$$

Finally notice that both $U_s(z^*, \mu_{HL}, 1, S_L^*)$ and $U_s(z^*, \overline{\mu}, 1, S_H^*)$ increase as $\overline{\mu}$ increases. Therefore in equilibrium $\overline{\mu}$ will be equal to its highest possible value. This completes the proof.

Proof of Proposition 4: To prove Proposition 4 we will make use of the Lemmas 1.S through 5.S.

We know by Lemma5.S that we can find a solution $(z^*, \mu^*, \lambda^*, S_j^*)$ by maximizing the shareholders' payoff over the set $N^{S'}$.

(i) When $q_L D \leq K$ we know by Lemma 2.S that the only possible equilibrium is $(\mu = 1, \lambda = 0)$. In this case the introduction of protective measures can not alter the shareholders' surplus because litigation is not possible.

(ii) When $q_H D > K$ all the equilibria in $N^{S'}$ are possible and $\overline{\mu} > 1$. By Lemma 4.S, we know that if $w < D$ and the optimal contract induces an equilibrium with litigation this contract will include a liability insurance

$$\left(I^*(\mu, \lambda, S_j^*) = 1,\ \beta^*(\mu, \lambda, S_j^*) = \frac{w}{D} \right).$$

The shareholders payoff in each case is

$$U_s(z^*, 1, 0) = (1 - p_H) - c_H - C - \frac{(1 - p_L)c_H}{p_L - p_H},$$

$$U_s(z^*,\mu,1,S_H^*) = (1-p_H) - c_H - C$$
$$- \max\left\{0, \frac{(1-p_L)c_H - \min\{w,D\}\,(p_L-p_H)\,q_H}{p_L-p_H}\right\}.$$
$$U_s(z^*,\mu_{HL},1,S_L^*) = (1-p_H) - c_H - C$$
$$- \max\left\{0, \frac{(1-p_L)c_H - \min\{w,D\}\,[(1-p_H)p_Lq_L - (1-p_L)p_Hq_H]}{p_L-p_H}\right\}$$
$$-(1-\frac{q_LD-K}{q_LD})\,(p_L-p_H-c_H) - \frac{q_LD-K}{q_LD}K\left(p_H + p_L\frac{K-q_HD}{q_LD-K}\right).$$

In this case $U_s(z^*,1,1,S_H^*)$ is always higher than $U_s(z^*,1,0)$. Therefore the relevant comparison is between $U_s(z^*,\mu,1,S_H^*)$ and $U_s(z^*,\mu_{HL},1,S_L^*)$. Simple calculations show that the difference $U_s(z^*,1,1,S_H^*)-U_s(z^*,\mu_{HL},1,S_L^*)$, is increasing in K, and that, for a given value of K, it is decreasing in $\min\{w,D\}$ for $\min\{w,D\} < \frac{(1-p_L)c_H}{[(1-p_H)p_Lq_L-(1-p_L)p_Hq_H]}$ and increasing in $\min\{w,D\}$ for higher values of $\min\{w,D\}$. Moreover, both for $\min\{w,D\} = 0$ and for $\min\{w,D\} \geq \frac{(1-p_L)c_H}{(p_L-p_H)q_H}$ the difference is strictly positive.

(iii) When $q_HD \leq K \leq q_LD$ all the equilibria in $N^{S'}$ are possible and $\overline{\mu} < 1$. Therefore, by Lemma 4.S, we know that if $w < D$ and the optimal contract induces an equilibrium with litigation this contract will include a liability insurance

$$\left(I^*(\mu,\lambda,S_j^*) = 1,\ \beta^*(\mu,\lambda,S_j^*) = \frac{w}{D}\right).$$

The shareholders payoff in each case is

$$U_s(z^*,1,0) = (1-p_H) - c_H - C - \frac{(1-p_L)c_H}{p_L-p_H},$$

$$U_s(z^*,\overline{\mu},1,S_H^*) = (1-p_H) - c_H - C$$
$$- \max\left\{0, \frac{(1-p_L)c_H - \min\{w,D\}\,(p_L-p_H)\,q_H}{p_L-p_H}\right\}$$
$$- \left(1 - \frac{q_L D - K}{(q_L-q_H)D}\right)(p_L - p_H - c_H)\,,$$

$$U_s(z^*,\mu_{HL},1,S_L^*) = (1-p_H) - c_H - C$$
$$- \max\left\{0, \frac{(1-p_L)c_H - \min\{w,D\}\,[(1-p_H)p_L q_L - (1-p_L)p_H q_H]}{p_L-p_H}\right\}$$
$$-(1 - \frac{q_L D - K}{q_L D})\,(p_L - p_H - c_H) - \frac{q_L D - K}{q_L D} K \left(p_H + p_L \frac{K - q_H D}{q_L D - K}\right).$$

The comparison between $U_s(z^*,\overline{\mu},1,S_H^*)$ and $U_s(z^*,\mu_{HL},1,S_L^*)$ is the same as in the previous case but now we also have to consider the equilibrium with no litigation. When $\min\{w,D\} = 0$ the equilibrium with no litigation gives the shareholders a higher payoff than any of the equilibria with litigation. Simple calculations show that both the difference $U_s(z^*,1,0) - U_s(z^*,\overline{\mu},1,S_H^*)$, and the difference $U_s(z^*,1,0) - U_s(z^*,\mu_{HL},1,S_L^*)$ are increasing in K, and that, for a given value of K, these differences are decreasing in $\min\{w,D\}$.

This completes the proof.

Proof of Proposition 5: To proof Proposition 5 one must compare the shareholders' utility under the two alternative regimes. Consider first the regime that allows out-of-court settlement. When control rents are low enough so that

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

this control rents can be completely extracted in an equilibrium with $\left(\mu = \min\left\{1, \frac{q_L D - K}{(q_L - q_H)D}\right\}, 1, S_H^*\right)$. This implies that $U_s\left(z^*, \min\left\{1, \frac{q_L D - K}{(q_L - q_H)D}\right\}, 1, S_H^*\right) > U_s\left(z^*, \mu_{HL}, 1, S_L^*\right)$. And the shareholders' utility under the settlement regime is equal to

$$\max\{U_s\left(z^*, \min\left\{1, \frac{q_L D - K}{(q_L - q_H)D}\right\}, 1, S_H^*\right), U_s(z^*, 1, 0)\}.$$

Consider now the regime where settlement is not allowed. The shareholders' utility when settlement is not allowed is equal to

$$\max\left\{U_s(z^*, \overline{\mu}, \widehat{\lambda}), U_s(z^*, 1, 0), U_s(z^*, 1, 1)\right\}.$$

with $\overline{\mu} = \min\left\{1, \frac{q_L D - K}{(q_L - q_H)D}\right\}$ and $\widehat{\lambda} = \frac{(1-p_L)c_H}{[(1-p_H)p_L q_L - (1-p_L)p_H q_H]\min\{w, D\}}$. A regime that allows settlement increases the shareholders utility because when

$$U_s(z^*, \overline{\mu}, \widehat{\lambda}) = \max\left\{U_s(z^*, \overline{\mu}, \widehat{\lambda}), U_s(z^*, 1, 0), U_s(z^*, 1, 1)\right\},$$

we have that

$$U_s\left(z^*, \min\left\{1, \frac{q_L D - K}{(q_L - q_H)D}\right\}, 1, S_H^*\right) - U_s\left(z^*, \min\left\{1, \frac{q_L D - K}{(q_L - q_H)D}\right\}, \widehat{\lambda}\right) =$$

$$\widehat{\lambda} K\left[p_L - (p_L - p_H)\min\left\{1, \frac{q_L D - K}{(q_L - q_H)D}\right\}\right] > 0.$$

And when

$$U_s(z^*, 1, 1) = \max\left\{U_s(z^*, \overline{\mu}, \widehat{\lambda}), U_s(z^*, 1, 0), U_s(z^*, 1, 1)\right\},$$

we know that $\min\left\{1, \frac{q_L D - K}{(q_L - q_H)D}\right\}$, and therefore we have

$$U_s(z^*, 1, 1, S_H^*) - U_s(z^*, 1, 1) = p_H K > 0.$$

This completes the proof.

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