The pricing of shares in equity markets with securities class action lawsuits

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Abstract

This study develops an analytical model of a securities market in which investors can engage in securities class action lawsuits following a firm’s release of unfavorable news. Because all investors in the model have rational expectations, the model takes into account the fact that the buyers of the firm’s shares anticipate litigation, which reduces the price they are willing to pay and amplifies the price reaction to bad news. I derive the equilibrium prices in this model and apply it to the issues of litigation insurance, links between firm-specific information and cost of capital, and manipulations of financial reports by the firm’s managers.
1 Introduction

In Rule 10b-5 class actions, investors can sue a firm in order to recover damages that arise from their reliance on misleading information provided by the firm’s managers. Under the fraud-on-the-market theory, investors do not have to establish that they personally relied on the firm’s disclosures; rather, they only need to assert that the market price at which they purchased shares was based on misrepresentations (See, e.g., Cornell and Morgan 1990). If the plaintiffs in such suits win or gain settlement, either the corporation, itself, or its insurer pays the damages (Alexander 1994). The costs of litigation can be substantial, perhaps enough to play a role in deterring non-US companies from listing in the US (Zingales 2007).

A fair amount of controversy surrounds securities class actions because the corporation, of which the plaintiffs are or at one time were owners, pays the damages. This creates what Coffee (2006) describes as the ‘circularity problem.’ The damages represent a wealth transfer between shareholders, much like a dividend, with a portion of the firm’s cost going to plaintiff attorneys or creating deadweight costs. Park (2009) argues that securities class actions are less circular than a dividend because, while dividends also involve transaction costs in the form of taxes, litigation transfers wealth from new investors to old investors and therefore spreads losses between them. Fox (2009) and Mitchell (2009) argue that securities class actions fail to compensate investors for losses that stem from relying on false disclosures, due in part to the costs involved, but may play a role in deterring violations of disclosure requirements. Fisch (2009) further argues that securities class actions increase investors’ incentives to engage in informed trading, and therefore price efficiency, by compensating informed investors and reducing the costs of trading based on corporate disclosures.

This paper develops an analytical model of a market in which shareholders can sue the firm (or its insurer) in the event of price drops that represent the revelation
that prior disclosures overstated the value of the firm. The model is static in that investors purchase shares in one period, following the release of information, and sell the shares in a subsequent period following another release of information. The original buyers can sue if the second information release is unfavorable. The model assumes that investors are perfectly competitive, risk-neutral, and have rational expectations. Rational expectations play a key role in the model and, in fact, completely undermine the notion of class action lawsuits as a means of compensation. This is because investors purchasing shares after the release of bad news anticipate litigation as discussed by Alexander (1994) and found empirically by Gande and Lewis (2009). On average, whatever the plaintiffs hope to gain via litigation, they have already paid for in the form of a low price when they sold to new shareholders.

On the other hand, the model shows that litigation, and, in particular, the transaction costs involved with litigation, can play a role in encouraging informative disclosure by firms. This occurs because investors buying shares know that bad news will force them to sell at a discounted price that reflects both bad news and the company’s anticipated litigation costs. If the company has an insurance policy that covers litigation costs, then the original owners of the company still will have prepaid the costs of the litigation via the insurance premium. If investors successfully sue, they will only recover a portion of the firm’s litigation costs because some of those costs are lost to attorney fees and deadweight costs (hereafter ‘transaction costs’). Thus, share prices reflect the value of the firm less the expected transaction costs from litigation. This reduction in firm value from expected litigation costs creates an incentive to improve disclosures because expected transaction costs are increasing in uncertainty about the firm value.

Transaction costs from litigation thus play a crucial role in how litigation affects corporate behavior. If there were no transaction costs, litigation would represent zero-sum side bets between old and new investors. The bets would be fairly priced,
so that there would be no impact on initial share prices. For example, if an investor
expected to receive $100 from litigation, he would also expect to receive exactly $100
less from selling his shares. Transaction costs imply that the total value of the firm
is not completely shared between old and new investors and play a role similar to a
budget-breaker in Holmström’s (1982) analysis of moral hazard in teams that relaxes
the restriction that the team’s work product is completely divided amongst the team.

Determining prices when shareholders can sue involves a fixed point problem because,
following bad news that could invite litigation, lower prices increase the magnitude of
potential damages the firm might pay. While the original investors have the opportunity
to sue, this ability reduces the value of their shares because the investors purchasing
shares impound the firm’s expected litigation costs. Thus, the ability to sue reduces the
original value of the firm’s shares by the transaction costs of litigation. This phenomenon
is the similar to that found in Kraakman, Park, and Shavell’s (1994) study of derivative
lawsuits, which are filed against corporate managers. Because investors in their model
decide to sue \textit{ex post}, litigation can occur even when it reduces firm value \textit{ex ante}.

In the context of a parameterized model with normally distributed random variables,
I show that the reduction in firm value from litigation takes a simple form that is
proportional to the standard deviation of expected firm value conditional on available
information. I assume that damages are proportional to the price change that occurs
when the original investors sell to new investors. This assumption roughly accords with
the commonly used ‘value-line’ approach to estimating out-of-pocket damages (Cornell
and Morgan 1990).\footnote{I discuss this further in Section 2} I model the transaction costs from litigation as proportional
to damages, and therefore to the price drop. This reflects the use of proportional
contingency fees to compensate plaintiffs attorneys and the notion that corporate
managers’ willingness to divert more time and resources to defend against litigation
is likely related to the size of potential damages. I apply this model to three settings to illustrate the impact of litigation.

In the first setting, I recompute the equilibrium under the assumption that the original owners of the firm purchase an insurance policy that covers litigation costs. I assume that the insurers are rational, risk-neutral and perfectly competitive so that they charge a premium that allows them to breakeven, on average. Prices take a similar form to the equilibrium without insurance, with the exception that the expected litigation costs are lower. Whether or not the firm has insurance, the original investors’ ability to litigate resembles a put option that allows them to recover a portion of a price drop. When the firm has no insurance, the investors purchase this put option from new investors. The new investors make the old investors pay for the put option by lowering the price they are willing to pay for the firm’s shares. The new investors’ ability to insulate themselves against the firm’s expected litigation costs by paying less for the shares exacerbates the price drop upon the release of bad news. When the firm has insurance, the new investors have no need to protect themselves against the cost of the suit. They simply pay for the expected value of the firm, net of the premium paid to the insurance company.

The price drop from bad news is less severe when the company has insurance because the new investors know that the insurance company will pay any damages if the old investors sue. In this case, the price drops dollar-for-dollar from the release of bad news and therefore more closely approximates the theoretically correct basis for computing damages (Alexander 1994). The expected transaction costs are therefore lower when the firm has insurance because transaction costs are proportional to damages, and therefore to the price drop, which are smaller when the firm has insurance. While insurance reduces the expected magnitude of litigation, it increases the expected frequency of litigation. The increased frequency arises because the lower litigation costs imply higher
initial share prices which, in turn, make price drops more likely.

In a second setting, I analyze the effect of litigation on capital costs. Because the initial share price is discounted by expected transaction costs that are proportional to uncertainty about firm value, there is a direct link between the quality of the firm’s disclosures and its cost of capital. This effect is a non-diversifiable ‘numerator effect,’ in contrast to the diversifiable disclosure effects discussed by Hughes, Liu, and Liu (2007) and Lambert, Leuz, and Verrecchia (2009). While improvements in information quality increase firm value, they also increase expected returns computed as expected changes in share prices. This is because the pre-news price is reduced by the transaction costs of litigation while the post-bad news price is reduced by the entire amount of litigation costs. An improvement in information quality therefore has a greater impact on the post-news price than the initial price, increasing the expected return. For example, suppose that an improvement in information quality reduces the company’s expected litigation costs by $100 and transaction costs are 30% of the total litigation costs. The post-news price will be higher by $100 while the pre-news price will be higher by $30, which equals the $100 higher expected post-news price and the $70 reduction in expected payments from litigation, net of 30% transaction costs. The expected return between the pre- and post-news prices is therefore higher by $70, which equals the $100 increase in the post-news price less the $30 increase in the pre-news price.\footnote{Another way to see this is to note that investors are risk-neutral and perfectly competitive so that they earn a zero total return on average. If the original investors’ expected net gains from litigation decrease by $70, there must be a corresponding $70 increase in expected return from share prices to maintain their breakeven total return.}

In the third setting, I consider a setting where the firm’s manager can manipulate his public reports and investors are uncertain of his objective function (Fischer and Verrecchia 2000). The presence of litigation does not alter the manager’s reporting strategy versus the Fischer and Verrecchia (2000) model because the marginal effect of the report on price is exactly the same. On the other hand, the ability to bias
increases the expected transaction costs that reduce the firm’s price and therefore affect the manager’s *ex ante* decisions that impact the effects of bias. Consistent with litigation playing a deterrent role, if there are transaction costs associated with litigation, it provides the firm with *ex ante* incentives to implement governance and reporting procedures to deter the manager from making misleading financial reports. The firm’s owners can increase the value of the firm taking actions that increase the costs of misreporting, such as hiring auditors that can better detect misstatements. Such actions reduce expected transaction costs from litigation and therefore increase firm value.

While there is a large literature on shareholder suits, I am not aware of any rational expectations models of securities class action suits. Kraakman, Park, and Shavell (1994) develop a model of derivative suits in which investors sue managers and explain how the inability to commit whether or not to sue results in lawsuit decisions that may be inconsistent with maximizing firm value. Trueman (1997) and Hensler (1995) consider settings where investors can sue and damages are paid by a party other than the corporation - namely, the manager and an entrepreneur, respectively. Hughes and Thakor (1992) examine a setting in which investors in an initial public offering (IPO) can sue the IPO’s underwriter in order to explain the phenomenon of IPO underpricing. While they briefly consider the price effects when the company, itself, may pay damages, the damages in that case entail no transaction costs and therefor would have no impact on the firm’s initial value.³

The remainder of the paper proceeds as follows. Section 2 develops the base model. Section 3 applies the model to litigation insurance, the relation between firm-specific information and the cost of capital, and managerial manipulations of financial reports. Section 4 concludes. All proofs are included in the Appendix.

³Shareholders who sell and can also litigate will receive a dollar less from the sale price for every dollar they expect to obtain from litigation, so that their *ex ante* benefit is zero.
2 Model and equilibrium

2.1 General model

The model occurs in five steps as shown in Figure 1. At Time 0, the manager or entrepreneur chooses an action that will ultimately affect the firm’s terminal dividend \( v \in [\bar{v}, \tilde{v}] \).\(^4\) At Time 1, the manager releases a report \( r \), other information \( y \) becomes available and Time 1 investors purchases shares for price \( p_1 \). At Time 2, investors observe signal \( s \) and Time 2 investors purchase shares from Time 1 investors at the price \( p_2 \).\(^5\) At Time 3, the firm generates a terminal dividend \( v \). If Time 1 investors successfully sued, the damages are paid out of the terminal dividend. I assume that Time 1 investors can only sue if they incur a loss (\( p_2 < p_1 \)).

(I insert Figure 1 about here)

I assume that all investors are risk-neutral, perfectly competitive and have rational expectations. Investors at Time 2 will incorporate any expected impact of a lawsuit when purchasing shares. I denote the probability of a successful lawsuit by \( \theta \) and the damages, which include all costs to the firm inclusive of transaction costs, by \( d \). This gives the Time 2 price of:

\[
p_2 = E[v - \theta d | r, y, s] = E_2[v - \theta d],
\]

where I use the notation \( E_t[\cdot] \) to denote the expectation conditional on information available at Time \( t \).

At Time 1, investors price shares based on the expected value of their sale price, \( p_2 \), and the potential to recover damages. The latter component reflects the ‘litigation put’

\(^4\)If the either limit is unbounded, then denote the range by, for example, \( v \in (-\infty, \infty) \).

\(^5\)Later in this section, I discuss how the choice to litigate would be affected if shareholders did not sell at Time 2.
discussed by Alexander (1994). I assume that investors incur costs of fraction $\alpha$ of any damages, giving:

$$p_1 = E_1[p_2 + \theta(1 - \alpha)d|\hat{r}, y] = E_1[E_2[v - \theta d] + \theta(1 - \alpha)d]$$

$$= E_1[v - \theta \alpha d],$$

where the second equality in (2) follows from substituting (1) for $p_2$. The notion of making transaction costs proportional to damages reflects both proportional contingency fees to plaintiff attorneys and the idea that the amount of time and resources the firm’s managers divert to defending against the lawsuit are likely proportional to the damages.

Note that the market price does not add any extra value from the litigation put; rather, the price is discounted for the portion of damages that do not accrue to shareholders due to transaction costs. Expression (2) highlights that the share price bears a discount for the expected transaction costs regardless of how damages are computed.

Another implication of (2) is that lawsuits only impact the price $p_1$ if there are transaction costs. Absent transaction costs, litigation has no impact on $p_1$ so that the Time 1 price cannot be used as a channel through which litigation can impact managers’ behavior. If there are no transaction costs ($\alpha = 0$), then the lawsuit simply represents a fair side bet (zero expected value) between the Time 1 and Time 2 shareholders. The value of the firm gets carved into damages $d$ and a residual $v - d$ to Time 2 shareholders, but no value is lost. If lawsuits are to play a role in influencing corporate behavior via the Time 1 price $p_1$, it is necessary that there be some transaction costs. This is analogous to the need for a budget-breaker in order to resolve multi-party moral hazard problems that cannot be solved if the parties’ output must be completely divided amongst the parties (Holmström 1982).
The remainder of the analysis assumes that damages are proportion $\gamma$ of the Time 1 investors’ loss $p_1 - p_2$. This assumption roughly accords with the use of the ‘value-line’ approach to estimate damages (Cornell and Morgan 1990). The out-of-pocket damages are as follows for an investor who purchased at 1 and sold at 2 where $p$ denotes actual prices and $p^*$ denotes the hypothetical, true-value, price had the company made no misrepresentations or omissions:

$$\text{Damages} = (p_1 - p^*_1) - (p_2 - p^*_2) = \left( p^*_2 - p^*_1 \right) - \left( p_2 - p_1 \right).$$ \hspace{1cm} (3a)$$

If the investor sold after the misrepresentation was corrected, it is typically assumed that the observed and hypothetical price are equal giving damages equal to $p_1 - p^*_1$. Under the value-line approach, an expected return model such as the CAPM is used to estimate $p^*_1$ using expected returns and the price at time 2. For example, if the expected return for the period 1 to 2 estimated from a market model is $\hat{r}_{1,2}$, then:

$$\text{Damages} = p_1 - p^*_1 = p_1 - \frac{1}{1 + \hat{r}_{1,2}}p_2,$$ \hspace{1cm} (3b)$$

which closely resembles my assumption of damages based on the price drop.\(^6\) Dybvig, Gong, and Schwartz (2000) note that the use of price changes to compute damages gives investors a free option that allows them to file suit when the price drops, perhaps for factors unrelated to a misstatement, and refrain from filing suit when the arrival of other information causes the price to rise on the day when the misstatement is corrected. This free option is also present in my model because the damages are based on the price change rather than misstatements, \textit{per se}. The assumption that damages may be less

\(^6\)Lev and de Villiers (1994) discuss and critique the practice of using the price drop upon the disclosure of bad news as the starting point for computing damages. Dybvig, Gong, and Schwartz (2000) state that this critique played a role in modifying the maximum damages allowable under the Private Securities Litigation Reform Act of 1995 to the difference between the investors’ purchase price and the 90-day average price following the correction of the company’s misstatement. I expect that this cap is also correlated with the price drop at Time 2 so that my assumption that damages are proportional to the max\{$0, p_1 - p_2$\} remains fairly descriptive of actual damages.
than the entire price drop ($\gamma \leq 1$) reflects the fact that settlements often fall far short of investor losses. For example, Coffee (2006) refers to studies by NERA Economic Consulting that find that the ratio of settlements to investor losses has never exceeded 7.2% between 1991 and 2004.

**Proposition 1.** The Time 1 and 2 prices are as follows if (a) awarded damages are $\gamma \max\{0, p_1 - p_2\}$ in the event that Time 1 shareholders successfully sue, (b) transaction costs are portion $\alpha$ of damages, (c) $\partial E_2[v]/\partial s > 0$ for all $s$, (d) $E_2[v]$ approaches $v$ as $s$ approaches its minimum $\bar{s}$ and (e) $E_2[v]$ approaches $\bar{v}$ as $s$ approaches its maximum of $\bar{s}$:

$$p_1 = E_1[v] - K_1$$

$$p_2 = E_2[v] - \frac{E_2[\theta \gamma]}{1 - E_2[\theta \gamma]} \max\{0, p_1 - E_2[v]\},$$

where $K_1$ is a nonnegative function that is measurable with respect to the Time 1 information set.

The amount subtracted from $E_2[v]$ in (4b) is analogous to the payoff of a put option. Because of the opportunity to sue, the Time 2 investors are providing downside protection to the Time 1 investors and charge them for this protection by paying a lower price for the firm’s shares. Figure 2 provides an illustration of how the Time 2 price $p_2$ drops in anticipation of litigation. The lower price essentially reflects the premium charged by the Time 2 investors for a put option sold to the Time 1 investors.

(Insert Figure 2 about here)

In a pure exchange setting with no externalities, shareholders do not benefit from the ability to sue; rather, the ability to sue reduces their payoff. Litigation is socially suboptimal in such a setting to the extent that transaction costs include welfare-reducing deadweight costs. Considering a Time 1 price as an initial public offering, the expected
price will be $E[p_1] = E[v] - E[K_1]$. To the extent that the initial owners can make decisions, such as implementing governance structures, that increase the expected value of the firm, they will do so even absent the potential for lawsuits because the term $E[v]$ will reflect the value of such decisions to the extent that there are no externalities. On the other hand, if the initial owners’ decisions create externalities not reflected in $E[v]$, then it is possible that lawsuits, via $E[K_1]$ provide a means of making the initial owners internalize the costs of actions such as overstating the productivity of their firm, but only if there are transaction costs so that $E[K_1] > 0$.

Given that the ability to sue reduces the the expected value of the firm, it is natural to consider when investors have incentives to sue. If an investor has sold shares and can sue, he has an incentive to do so because he only stands to gain. Of course, because the price at which he sold took this into account, the investor’s suit merely allows him to recover what he paid for in advance via a low sale price $p_2$.

The incentives to sue do not depend on shareholders who have closed their positions in a company’s shares, though. Alexander (1994) notes that total damages are based on an estimate of a class based on shareholder transactions. The damages are paid on a pro rata basis to shareholders who join the class. Alexander (1994) refers to several cases in which few eligible shareholders file claims, sometimes representing as low as 40% of market losses for a class. Cox and Thomas (2005) find that even institutions often fail to file claims for which they are eligible, citing survey evidence that in which institutional investors refer to difficulty in learning about claims for which they are eligible. This suggests that many investors are either unaware of suits or own too few shares to bother filing. Because of this, shareholders can sometimes recover more than their realized losses.

Formally, suppose that a shareholder owns fraction $\eta_1$ of the firm’s shares at Time 1 and $\eta_2$ at Time 2. Conditional on a class action lawsuit, the shareholder should join
because joining the lawsuit will not affect the total damages paid, but will allow him to collect a pro rata portion of the damages. If no suit has been filed and the shareholder is considering filing, he must consider what fraction $\pi$ of other investors will join the suit. If he does not sue, his expected payoff is $\eta_2 E_2[v] + (\eta_1 - \eta_2)p_2$. If he sues, his expected payoff is:

$$
\eta_2 E_2[v] + (\eta_1 - \eta_2)p_2 + \frac{\eta_1}{\eta_1 + \pi(1 - \eta_1)} \theta \gamma (1 - \alpha)(p_1 - p_2) - \frac{\eta_2 \theta \gamma (p_1 - p_2)}{\eta_1 + \pi(1 - \eta_1)} = \eta E_2[v] + (\eta_1 - \eta_2)p_2 + \frac{\eta_2(1 - \eta_1)}{\eta_1 + \pi(1 - \eta_1)} \left( \frac{\eta_1 - \eta_2 - \alpha}{\eta_2 - \eta_1} - \pi \right) \theta \gamma (p_1 - p_2), \quad (5)
$$

where the net damages are positive if $\pi < \frac{\eta_1 - \eta_2 - \alpha}{\eta_2 - \eta_1}$. If there are no transaction costs ($\alpha = 0$) and the shareholder was not a net purchaser at Time 2 ($\eta_1 \geq \eta_2$), then any hope that some shareholders will ignore the suit ($\pi < 1$) will induce the shareholder to file. If the shareholder sold his entire position at Time 2 ($\eta_2 = 0$), then he will always file. If the shareholder sold no shares ($\eta_1 = \eta_2$), then a shareholder holding approximately 0% of the firm’s shares will find it advantageous to sue if he believes that shareholders representing fewer than $1 - \alpha$ of total ownership will join the suit. Figure 3 illustrates the threshold $\pi$ for different levels of transaction costs. The maximum expected participation $\bar{\pi}$ under which the investor will file suit declines as transaction costs increase or as the portion of ownership increases.

(Hughes and Thakor (1992) show that expected payouts from litigation can give the appearance of the long-term underperformance of IPOs. The same forces are at work in

Hughes and Thakor (1992) do not account for the impact of the payout on the firm’s cash flows, so that the damages paid to shareholders appear as an ‘extra’ source of value. If one takes into account the impact on the firm’s cash flows, the litigation has a net zero impact on selling investors because they have no transaction costs. In expectation, shareholders receive a dollar less when selling shares for...
this model. Shareholders in this study are risk-neutral, so that investors’ total expected returns are zero. If one were to measure returns from security prices, alone, the returns to Time 2 investors will appear to be negative because:

\[ \mathbb{E}[p_2 - p_1] = -\mathbb{E}[\theta \gamma (1 - \alpha) \max(0, p_1 - p_2)] < 0. \]  

(6)

The prices do not incorporate the Time 1 investors’ expected ‘side gain’ from litigation which, combined with the competitive pricing that gives zero expected returns, implies a negative return based on prices, alone.

2.2 Parameterized model

In order to set the stage for further analysis, I derive prices in a parameterized model with normally distributed random variables. In particular, I assume that all parties share the common prior belief \( v \sim \mathcal{N}(\mu_v, \tau_v^{-1}) \) and that all signals are jointly normally distributed with \( v \). The Time 1 signals are \( r = v + e_r, \quad e_r \sim \mathcal{N}(0, \tau_r^{-1}) \) and \( y = v + e_y, \quad e_y \sim \mathcal{N}(0, \tau_y^{-1}) \). The Time 2 signal is \( s = v + e_s, \quad e_s \sim \mathcal{N}(0, \tau_s^{-1}) \). I assume that \( e_r, e_s \) and \( e_y \) are independent of \( v \). I assume that the fractions \( \theta, \gamma \) and \( \alpha \) are constants. The following proposition gives the main result of this section:

**Proposition 2.** The Time 2 price \( p_2 \) is:

\[ p_2 = \mathbb{E}_2[v] - \frac{\theta \gamma}{1 - \theta \gamma} \max(0, p_1 - \mathbb{E}_2[v]). \]  

(7a)

The Time 1 price \( p_1 \) and Time 2 price \( p_2 \) are as follows, where \( \text{std}_1(\cdot) \) denotes the

\begin{itemize}
  \item every dollar they expect to recover in litigation. Nonetheless, their intuition about the effect on stock performance still holds.
\end{itemize}
standard deviation conditional on Time 1 information:

\[ p_1 = E_1[v] - k(\theta \gamma, \alpha) \text{std}_1(E_2[v]) \]  
\[ p_2 = E_2[v] - \frac{\theta \gamma}{1 - \theta \gamma} \max\{0, E_1[v] - E_2[v] - k(\theta \gamma, \alpha) \text{std}_1(E_2[v])\}, \]

where \( k > 0 \) does not depend on signal realizations.

Proposition 2 shows that price in this model maintains a tractable, linear form despite the apparent nonlinearities resulting from the ability to sue. As a result, a variety of settings in which parties have linear strategies will carry over to the setting in which investors can sue for damages. In this setting, the expected transaction costs \( E_1[\theta \gamma \alpha d] = k \text{std}_1(E_2[v]) \) do not depend on the Time 1 information because the Time 1 price and the expectation of future prices shift in tandem. As a caveat, though, note that this result depends on the fact that the conditional variance of a normal random variable is constant. In the case of other distributions, a shift in the location of the expected value would also cause a change in variance that would alter the value of the ability to litigate.

The following corollary provides comparative statics that characterize \( k \).

**Corollary 3.** The function \( k > 0 \) is increasing in both \( \theta \gamma \) and \( \alpha \). Furthermore, \( k(\theta \gamma = 0, \alpha) = k(\theta \gamma, \alpha = 0) = 0 \) and \( k \to \infty \) as \( \theta \gamma \to 1 \).

Because \( k \text{std}_1(E_2[v]) \) represents the expected transaction costs from litigation, it is intuitive that \( k \) is increasing in both \( \theta \gamma \) and \( \alpha \), both of which are proportional expected to transaction costs. The function \( k \) becomes unbounded as \( \theta \gamma \to 1 \) because of a ‘downward spiral’ type effect where the Time 2 investors lower the price \( p_2 \) in expectation of paying damages, which increases the magnitude of the damages.

The next section presents applications of the equilibrium in Proposition 2.
3 Applications

3.1 Insurance

Many firms carry at least some litigation insurance (Coffee 2006). This section shows that the character of the price at Time 1 and the ex ante value of the firm closely resemble that in Proposition 2, but has some distinctions. In order to derive the prices in this setting, assume that at Time 0, the firm pays a premium $x$ to an insurer for a policy to cover all litigation costs incurred by the firm. I assume that insurers are perfectly competitive and risk-neutral so that they break even ex ante. In this case, the Time 1 and 2 prices are:

$$p_2 = E_2[v] - x$$
$$p_1 = E_1[p_2 + \theta \gamma (1 - \alpha) \max\{0, p_1 - p_2\}]$$

where, as in the previous section, a successful suit obtains total damages of $\gamma \max\{0, p_1 - p_2\}$ and fraction $\alpha$ of the damages are lost to transaction costs. Maintaining our assumptions of joint normality, the following proposition summarizes the equilibrium prices:

**Proposition 4.** If firm obtains full insurance for litigation at cost $x$ from a perfectly competitive, risk-neutral insurer, then the premium is:

$$x = \frac{1}{\alpha} k_2(\theta \gamma, \alpha) \text{std}_1(E_2[v]),$$

and prices are:

$$p_1 = E_1[v] - k_2(\theta \gamma, \alpha) \text{std}_1(E_2[v])$$
$$p_2 = E_2[v] - \frac{1}{\alpha} k_2 \text{std}_1(E_2[v]).$$

where the function $k_2 > 0$.

The Time 1 price given in (9b) closely resembles that in (7b) in that both deduct a cost for litigation that is proportional to $\text{std}_1(E_2[v])$. 

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Like the function $k(\theta \gamma, \alpha)$ when the firm has no insurance, the function $k_2(\theta \gamma, \alpha)$ is increasing in both $\theta \gamma$ and $\alpha$. The impact of litigation on the price $p_1$ equals $\theta \gamma \alpha E_1[\max\{0, p_1 - p_2\}]$ which equals $k_2 \text{std}_1(E_2[v])$ when the firm has insurance and $k \text{std}_1(E_2[v])$ when it does not. The following corollary states a key difference between the two functions:

**Corollary 5.** The function $k_2 > 0$ is increasing in both $\theta \gamma$ and $\alpha$. Furthermore, $k_2(\theta \gamma = 0, \alpha) = k_2(\theta \gamma, \alpha = 0) = 0$ and $k_2$ is bounded above by $\phi(0) \approx 0.4$. For given values of $\theta \gamma$ and $\alpha$, the function $k_2$ is less than $k$. Thus, the expected costs of litigation are lower when the firm has insurance.

The intuition for this corollary is that the damages are proportional to the price drop at Time 2. When the firm has litigation insurance, a comparison of prices $p_2$ and $p_1$, given by (9b), shows that the price drops dollar-for-dollar for the difference $E_1[v] - E_2[v]$. A comparison of the prices without insurance shows that, conditional on a price drop, the price drops by $\frac{1}{1-\theta \gamma} > 1$ for every dollar difference between $E_1[v]$ and $E_2[v]$. Figure 4 Panel (a) illustrates the Time 2 price under the insurance and no-insurance scenarios, which illustrates the steeper price drop in the no-insurance case. This steeper slope in the price drop for the no-insurance case arises from the Time 2 investors impounding the expected payout from litigation and amplifies the price drop. As shown in Figure 4 Panel (b), the higher price drop amplifies the amount of expected damages in the no-insurance case relative to the case when the firm has insurance. Because transaction costs are proportional to total litigation costs which, in turn, are proportional to the price drop, insurance lowers the transaction costs from litigation by avoiding the amplified price drops from bad news that occur when the firm has no insurance. The lower transaction costs when the firm has insurance perhaps plays a role in explaining why, as Coffee (2006) notes, “all public corporations carry” Directors’ and Officers’ insurance policies.

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8I use the notation $\Phi$ and $\phi$ for the cumulative distribution and density of a standard normal random variable.
The proof that $k_2 < k$ follows from an inspection of a plot of the two functions, which depend solely on $\theta \gamma \in [0, 1]$ and $\alpha \in [0, 1]$, allowing a plot of all possible values of the two functions as shown in Figure 5. Unlike the case without insurance, the litigation cost component of prices is bounded when the firm has insurance and the expected costs of litigation are lower.

The different character of price drops between the no-insurance and insurance cases has implications for the computation of damages. Lev and de Villiers (1994) discuss the need to exclude the ‘crash component’, which they describe as “unrelated to fundamental values”, of a share price drop from the computation of damages. The reason being that plaintiffs are only entitled to recover the portion of the price drop due to information about the firm’s value, rather than indirect costs such as anticipated litigation (Alexander 1994). The dollar-for-dollar slope in the price drop of firms with litigation insurance more closely approximates this notion.

While Corollary 5 demonstrates that insurance reduces the costs of litigation, the following corollary shows that insurance increases the likelihood of litigation:

**Corollary 6.** For fixed values of $\theta \gamma$ and $\alpha$, the probability of litigation when the firm has insurance is $\Phi \left( \frac{1 - \alpha}{\alpha} k_2 \right)$ and exceeds the probability of litigation, $\Phi(-k)$, when the firm has no insurance. When the firm has insurance, the probability of litigation is increasing in $\theta \gamma$ and decreasing in $\alpha$. When the firm has no insurance, the probability of litigation is decreasing in both $\theta \gamma$ and $\alpha$.

In order to understand why the probability of litigation is higher when the firm has insurance, refer again to Figure 4. The horizontal lines in Figure 4 Panel (a) plot the
Time 1 prices with and without insurance, where the price with insurance is greater since $k_2 < k$ as stated in Corollary 5. Conditional on the Time 2 price $p_2$ exceeding the Time 1 price $p_1$, the price $p_2 = E_2[v]$ if the firm has no insurance because the firm will pay nothing for litigation. The Time 2 price with insurance is $E_2[v]$ less the insurance premium $x$, which was paid ex ante and does not depend on whether or not a lawsuit occurred. The higher Time 1 price with insurance is greater than the Time 2 price, resulting in potential litigation, for any value of $E_2[v]$ less than the value $E_c$ denoted on the figure. In the no-insurance case, the Time 1 price is lower and, absent a lawsuit, the Time 2 price is higher, so that the Time 2 price falls below the Time 1 price for any $E_2[v] < E_b < E_c$. Price drops, and therefore litigation, are thus more likely when the firm has insurance.

The relation between the likelihood of litigation and the parameters $\theta_\gamma$ and $\alpha$ is intuitive in the insurance case. Higher $\theta_\gamma$ implies a higher expected payout to Time 1 investors who sue while a lower $\alpha$ implies that suing investors keep more of the firm’s total payout. In the no-insurance case, refer again to Figure 4 Panel (a). If there is no suit, the Time 2 price $p_2 = E_2[v]$ in the no-insurance case, while an increase in $\theta_\gamma$ reduces the Time 1 price $p_1$ on account of the higher expected transaction costs, which are proportional to damages. The lower the Time 1 price $p_1$, the less likely it is that the Time 2 price will fall below it. This phenomenon does not occur in the insurance case because an increase in $\theta_\gamma$ affects both the Time 1 and Time 2 prices. Both prices drop from the increase in the insurance premium that results from higher $\theta_\gamma$ implying higher expected litigation costs. The Time 2 price reflects only a drop from the premium increase. The Time 1 price also reflects the premium increase; however, there is a partially offsetting effect from the higher expected net-of-transaction-costs litigation payments that the Time 1 investors expect to receive. On Figure 4 Panel (a) this would be depicted as a rightward shift in the point $E_c$ where the Time 1 and Time 2 prices intersect for the insurance case.
The combined result of Corollaries 5 and 6 is that insurance reduces the magnitude but increases the frequency of litigation. The higher frequency is consistent with litigation insurance being a major determinant of settlement amounts (e.g., Alexander 1996).

Because the prices with and without insurance take similar forms, the remainder of this paper reports results using the $k$ notation that corresponds to the no-insurance case. This has no qualitative effects on the subsequent results. The subsequent results apply also to firms that have insurance, with the expressions being altered by simply replacing $k$ with $k_2 < k$.

### 3.2 Information and cost of capital

This section considers the choice of an entrepreneur to invest in technologies that improve information provided to investors. There is some debate in the accounting literature about the extent to which individual firm choices affect the cost of capital. In a pure exchange economy, Hughes, Liu, and Liu (2007) and Lambert, Leuz, and Verrecchia (2009) demonstrate that individual firm choices have an impact on cross-sectional differences in expected returns only to the extent that they affect exposure to systematic risk. Christensen, de la Rosa, and Feltham (2010) show that the ex ante cost of capital is independent of the firm’s reporting systems.

Taking the view that cost of capital refers to the firm’s price being less than the expected value of the future cash flows it produces, then the expected transaction costs $E[v - p_1] = k \text{ std}_1(E_2[v])$ in (7b) can be thought of as a capital cost. Note that this cost arises as a ‘numerator effect’, reducing the cash flows available to investors, rather than a ‘denominator effect’ due to risk. In our model with risk-neutral investors, expected returns are zero. However, part of the Time 1 investors’ expected payoff consists of the proceeds from litigation. This causes expected returns measured from prices alone,
The following corollary summarizes the effect of Time 1 information on prices and expected returns:

**Corollary 7.** The price $p_1$, and therefore the *ex ante* expected price $E[p_1]$ is decreasing in the Time 1 uncertainty about the value of the firm $\text{std}_1(E_2[v])$. The expected price return $E[p_2 - p_1]$ is decreasing in $\text{std}_1(E_2[v])$ and equals:

$$E[p_2 - p_1] = -\frac{1 - \alpha}{\alpha} k \text{std}_1(E_2[v]).$$

(10)

The impact of litigation on expected returns arises because Time 2 investors impound the expected costs of litigation in $p_2$. The Time 1 investors impound the expected transaction costs of litigation in $p_1$. An improvement in information quality (lower $\text{std}_1(E_2[v])$) therefore yields a greater increase in $p_2$, on average, than on $p_1$. In the extreme case when the Time 1 investors recover nothing ($\alpha = 1$), the Time 1 investors value the expected cost of litigation in exactly the same way as Time 2 investors and the expected return is zero. If there are no transaction costs, the expected costs remain negative because Time 2 investors deduct the expected costs of litigation when arriving at $p_2$ while litigation has no impact on the Time 1 price, $p_1$. This occurs because the effect of litigation on $p_2$ exactly offsets the Time 1 investors’ expected litigation payoff when $\alpha = 0$. While Corollary 7 implies that improvements in information quality (lower $\text{std}_1(E_2[v])$) increase expected returns, this model abstracts from risk aversion and the impact of information on returns will be negative in settings where the impact of risk aversion on returns dominates the pure litigation effect.

In order to illustrate how firm investments in governance and accounting systems impact firm value and the *ex ante* cost of capital, consider a simple case in which the

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9The term $\frac{1-\alpha}{\alpha}$ in (10) gives the appearance that the expected return becomes unbounded as $\alpha \to 0$; however, Corollary 3 shows that $k$ also approaches zero as $\alpha \to 0$. The expected Time 2 price $E_1[p_2; \alpha = 0] = E_1[v] - \frac{\theta}{1-\theta^2} \phi(0) \text{std}_1(E_2[v])$ when there are no transaction costs.
Time 1 information consists of only of the signal $r$ and the initial owners determine the precision $\tau_r$ by investing in accounting systems. Further assume that $e_r$ and $e_s$ are independent. From (7b), the expected price $E[p_1] = E[v] - k \text{std}_1(E[v])$ where:

$$\text{std}_1(E[v]) = \sqrt{\text{var}\left(\frac{\tau_v\mu_v + \tau_r r + \tau_s s}{\tau_v + \tau_r + \tau_s}\right)} = \sqrt{\frac{\tau_v(\tau_v + \tau_s)}{\tau_v + \tau_r + \tau_s}}.$$  

Expression (11) immediately implies the following corollary:

**Corollary 8.** The expected price of the firm, $E[p_1]$ and the expected price return $E[p_2 - p_1]$ are strictly increasing and concave in $\tau_r$. If the cost of precision is increasing in $\tau_r$, a sufficient condition for the firm to invest in information systems ($\tau_r > 0$) is that the marginal cost is zero at $\tau_1 = 0$.

Absent litigation in this model, the firm has no *ex ante* incentive to provide information because its shares are fairly priced, on average. Although investors may benefit from information in order to, for example, inform resource allocation decisions, the firm’s owners may have no incentive to provide it. The presence of costly litigation adds an incentive to produce information because better information about the firm reduces expected litigation costs and may therefore provide a means to induce the firm’s owners to internalize the benefit of information to investors.

### 3.3 Reporting bias

In this section, I consider a variation of the reporting bias model in Fischer and Verrecchia (2000) where the manager has incentives to bias his report and those incentives are unknown *ex ante*. This setting illustrates the very issue, misreporting by managers, that gives rise to many securities class actions.

As in Fischer and Verrecchia (2000), I assume that the manager privately observes the signal $r$ and makes a report $\hat{r}$. The manager’s objective function when determining
his report $\hat{r}$ is:

$$\max_r r \ E[p_1 | r] - \frac{c}{2} (r - \hat{r})^2.$$  \hfill (12)

The term $r \ E[p_1 | r]$ reflects the manager’s sensitivity to price and the term $\frac{c}{2} (r - \hat{r})^2$ reflects the costs of misreporting, as indexed by $c > 0$. Investors are unsure of the manager’s sensitivity to price, which depends on, for example, factors that favor higher prices such as the manager’s holding of securities and reputational benefits. The sensitivity can also depend on factors that favor lower prices such as expected option grants or repurchases to supply shares for broad-based employee stock option programs.

I assume that investors have the prior belief that $x \sim \mathcal{N}(\mu_x, \tau_x^{-1})$, independent of all other variables in the model. The term $c$ reflects the costs of manipulating the report such as additional effort or expected penalties. I do not model the penalties as a direct function of lawsuits, however, so that the penalty in (12) can be viewed as a reduced form that arises from activities such as deceiving auditors and, possibly, penalties for detected misreporting.

Because they are unsure of the manager’s objective function, investors must form a conjecture about the manager’s reporting strategy, which I denote by $\hat{r}$.\footnote{I abuse notation by using $\hat{r}$ to denote both the manager’s report and the investors conjecture.} Similarly, the manager must form a conjecture of how investors will respond to his report. I assume that both conjectures are linear and solve for the resulting equilibrium. The following denotes the respective conjectured form $\hat{p}_1$ of price and $\hat{r}$ of the report:\footnote{Under the assumption of linear conjectures, $E[v | \hat{r}, y]$ is linear so that the form of $\hat{p}_1$ in (13) is equivalent to an arbitrary linear conjecture.}

$$\hat{p}_1 = E[v | \hat{r}, y] + \hat{k}_0 + \hat{k}_r \hat{r} + \hat{k}_y y$$

$$\hat{r} = \hat{r}_0 + \hat{r}_r r + \hat{r}_x x.$$  \hfill (13)

The equilibrium is nearly identical to that in Fischer and Verrecchia (2000) because the marginal impact of the manager’s report on price is the same as on investors’
expectation of $v$, as in their model. I maintain the assumption of constant probability $\theta$ of losing a suit and portion $\gamma$ of losses recovered. This preserves the linear structure of the previous sections. In practice, these could increase in the amount of actual misstatements. Dybvig, Gong, and Schwartz’s (2000) argument that litigation partially depends on factors unrelated to misstatements partially mitigates concerns that might arise from assuming that $\theta$, $\gamma$ and $\alpha$ are independent of the manager’s misstatement $\hat{r} - r$. An indirect way to make $\theta$, $\gamma$ and $\alpha$ vary with misreporting while preserving the linear structure of the model would be to make them depend on factors such as $c$ and components of the covariance matrix of $[v, r, y, s, x]$, which are taken as constants in the manager’s objective function (12) but impact the amount of misreporting.

The following proposition states the resulting equilibrium under the assumption that $\text{corr}(e_r, e_y) < \sqrt{\frac{\tau_r}{\tau_y}}$.

Proposition 9. In the reporting bias setting, prices are given by Proposition 2 and $p_1$ equals:

$$p_1 = E[v|y] + \frac{\text{cov}(v, r|y)}{\text{var}(r|y) + r_x^2 \tau_x} (\hat{r} - E[r|y] - r_x \mu_x) - k \text{std}_1(E[v]).$$

The manager’s report $\hat{r}$ is:

$$\hat{r} = r + x \frac{1}{c} \frac{\text{cov}(v, r|y)}{\text{var}(r|y) + r_x^2 \tau_x},$$

where $r_x \in (0, \frac{1}{c})$ is the unique real root of the cubic equation:

$$r_x^3 + \tau_x \text{var}(r|y) r_x - \frac{1}{c} \tau_x \text{cov}(v, r|y) = 0.$$  

12The assumption that $\text{corr}(e_r, e_y) < \sqrt{\frac{\tau_r}{\tau_y}}$ insures that $\text{cov}(v, r|y) > 0$ which also insures that $E[v|\hat{r}, y]$ is increasing in $\hat{r}$ and a manager that prefers higher prices will make higher reports ($\hat{r} > r$). The assumption that $\text{corr}(e_r, e_y) < \sqrt{\frac{\tau_y}{\tau_r}}$ is sufficient, but not necessary, for claim that the endogenous parameter $r_x < \frac{1}{c}$ and also implies that $\text{cov}(v, y|r) > 0$ so that $E[v|\hat{r}, y]$ is increasing in $y$.
The manager’s *ex ante* payoff is:

$$E \left[ x E[p_1|r] - \frac{c}{2}(r - \hat{r})^2 \right] = \mu_x(E[v] - k \text{std}_1(E_2[v])) + \frac{c}{2} r_x^2 (\tau_x^{-1} - \mu_x^2).$$

As in Fischer and Verrecchia (2000), the manager benefits from the ability to bias if there is sufficiently large uncertainty about his objective function, \(\tau_x^{-1} > \mu_x^2\); otherwise, the manager’s inability to commit *ex ante* not to bias traps him into biasing despite that he suffers on average for it.

In cases where the manager expects to benefit from biasing (\(\tau_x^{-1} > \mu_x^2\)), he has incentives to take actions *ex ante* that improve the ability to bias. For example, the coefficient \(r_x\) is decreasing in the precision \(\tau_v\), which provides the manager with an incentive to take riskier projects (lower \(\tau_v\)) than he would absent the ability to bias.\(^\text{13}\)

On the other hand, increases in risk (lower \(\tau_v\)) directly increase \(\text{std}_1(E_2[v])\). The risk increases have an additional indirect effect that increases \(\text{std}_1(E_2[v])\) because \(\text{std}_1(E_2[v])\) is increasing in \(r_x\), which is decreasing in \(\tau_v\). The presence of litigation costs thus provides at least a partial deterrent to managers taking unnecessary risks.

Another *ex ante* action that can be taken by firm managers is developing accounting and governance procedures that increase the costs of misreporting. For example, hiring high quality auditors may make it more difficult to manipulate reports. This may be modeled as an increase in the cost \(c\) of misreporting. The bias parameter \(r_x\), and therefore \(\text{std}_1(E_2[v])\), is decreasing in \(c\) so that litigation provides an incentive to implement policies that make it more difficult to falsify financial statements. The term \(\frac{c}{2} r_x^2\) in the manager’s *ex ante* utility (15) also changes with \(c\). This may be either increasing or decreasing in \(c\) so that it can increase or decrease the incentives provided by litigation to implement policies that increase the cost of misreporting.\(^\text{14}\)

\(^{13}\)The fact that \(r_x\) is decreasing in \(\tau_v\) follows from applying the implicit function theorem to (14c).

\(^{14}\)Applying the implicit function theorem to (14c) shows that \(r_x\) is decreasing in \(c\); however, the product \(\frac{c}{2} r_x^2\) is increasing in \(c\) for small \(c\), where \(r_x\) is large, and is decreasing in \(c\) for large \(c\), where \(r_x\) is small.
4 Conclusion

Securities class action lawsuits create a circularity problem because the firm’s shareholders are ultimately both the beneficiaries and payers of damages. This study develops a rational expectations model in which shareholders anticipate litigation upon the release of bad news. This magnifies the price drop and therefore increases damages, which are often based on the drop in share value upon the release of bad news. In a setting with normally distributed random variables, the firm’s share prices have a tractable form despite the complexity that arises from the possibility for litigation.

I use the model to highlight several effects of litigation. I show that litigation insurance reduces the magnitude of price drops from bad news and therefore the transaction costs associated with litigation. While I also show that litigation is more likely when the firm has insurance, the smaller damages more than compensate for the higher likelihood of litigation so that the expected overall costs of litigation are lower when firms have insurance. I also show that litigation induces a firm-specific cost of capital effect because the firm’s shares include a reduction for the anticipated transaction costs of litigation. Finally, I show that the presence of litigation costs provides an \textit{ex ante} incentive for firms to implement governance and disclosure policies that discourage managers from manipulating financial reports. These effects depend on the presence of transaction costs of litigation, such as attorney fees, because, absent such costs, litigation is a simple dollar-for-dollar wealth transfer between investors that has no effect on the \textit{ex ante} value of the firm’s shares.

The equilibrium prices in this model take a simple, tractable form. This suggests that the model may be useful for future research on settings in which litigation affects share prices. Possible extensions include introducing risk-aversion in a large multi-security market or analyzing the effect of litigation on production and other resource allocation decisions.
References


Appendix

Proof of Proposition 1

I first determine the Time 2 price and work back in time. The Time 2 price $p_2$ equals the buyer’s expected payoff:

$$p_2 = E_2[v - \theta \gamma \max \{0, p_1 - p_2\}]. \quad (A.1)$$

Solving (A.1) for $p_2$ gives (4b).

The Time 1 investors determine their price based on their expected payoff, inclusive of any recovery from a lawsuit. Given costs $\alpha$, the Time 1 price $p_1$ solves:

$$p_1 = E_1[p_2 + \theta \gamma (1 - \alpha) \max \{0, p_1 - p_2\}] = E_1[E_2[v - \theta \gamma \max \{0, p_1 - p_2\}] + \theta \gamma (1 - \alpha) \max \{0, p_1 - p_2\}] \quad (A.2)$$

$$= E_1[v] - E_1[E_2[\theta \gamma \alpha \max \{0, p_1 - p_2\}].$$

The term subtracted from $E_1[v]$ represents the expected legal costs that the Time 1 investors will incur.

Substituting (4b) into (A.2) and simplifying gives:

$$p_1 = E_1[v] - \int_{s}^{s} p_1 \frac{E_2[\theta \gamma \alpha]}{1 - E_2[\theta \gamma]} (p_1 - E_2[v]) dF_1(s), \quad (A.3)$$

where $F_1(s)$ is the distribution of the Time 2 signal $s$ conditional on Time 1 information.

Assumptions (c) through (e) imply that there is a $\hat{s}$ that depends on Time 1
information and $p_1$ such that $E_2[v] < p_1$ if and only if $s < \hat{s}$.\textsuperscript{15} This then gives:

$$p_1 = E_1[v] - \int_{\hat{s}}^{s} \frac{E_2[\theta \gamma \alpha]}{1 - E_2[\theta \gamma]} (p_1 - E_2[v]) dF_1(s). \tag{A.4}$$

It remains to show that a $p_1$ exists that satisfies (A.4). The derivative of the right-hand-side of (A.4) with respect to $p_1$ is:

$$- \int_{\hat{s}}^{s} \frac{E_2[\theta \gamma \alpha]}{1 - E_2[\theta \gamma]} dF_1(s) - \frac{E_2[\theta \gamma \alpha; s = \hat{s}]}{1 - E_2[\theta \gamma; s = \hat{s}]} (p_1 - E_2[v; s = \hat{s}]) f_1(\hat{s}|s_2) \frac{d\hat{s}}{dp_1} = - \int_{\hat{s}}^{s} \frac{E_2[\theta \gamma \alpha]}{1 - E_2[\theta \gamma]} dF_1(s) < 0, \tag{A.5}$$

where the second equality in (A.5) follows because $p_1 - E_2[v; s = \hat{s}] = 0$ by the definition of $\hat{s}$. The condition $p_1 - E_2[v; s = \hat{s}] > 0$ for all $s < \hat{s}$ guarantees that the term subtracted in (A.4) is positive so that left-hand-side of (A.4) is greater than the right-hand-side at $p_1 = E_1[v]$. Because $v \geq \bar{v}$, $\hat{s}$ must equal $\bar{s}$ when $p_1 = v$ so that the right-hand-side of (A.4) exceeds the left-hand-side at $p_1 = v$, assuming $E_1[v] > v$. Thus, some $p_1 \in (v, E_1[v])$ must satisfy (A.4). Because $p_1 < E_1[v]$, $K_1 \equiv E_1[v] - p_1$ must be positive. Both sides of the relation (A.4) that determine $p_1$ depend only on Time 1 information, so $K_1$ only depends on Time 1 information.

\textbf{Proof of Proposition 2}

Time 2 investors are competitive and risk-neutral and therefore the price $p_2$ equals their expected payoff. Applying (4b) gives:

$$p_2 = E_2[v] - \frac{\theta \gamma}{1 - \theta \gamma} \max\{0, p_1 - E_2[v]\}. \tag{A.6}$$

\textsuperscript{15}Because damages are paid out of firm value, the portion $\gamma$ of recovery in a lawsuit would need to adjust as appropriate. For example, in a limited liability setting with $v = 0$, the expected recovery portion $E_2[\theta \gamma]$ would approach zero as $E_2[v]$ approaches zero in order to ensure nonnegative prices.
Time 1 investors are competitive and risk-neutral, as well, so that the price \( p_2 \) equals their expected payoff given by (A.3):

\[
p_1 = E_1[v] - \frac{\theta \gamma \alpha}{1 - \theta \gamma} E_1[\max\{0, p_1 - E_2[v]\}]. \tag{A.7}
\]

If \( E_2[v] \) is normally distributed conditional on Time 1 information, then \( E_2[v] \sim \mathcal{N}(E_1[v], \text{var}_1(E_2[v])) \) where \( \text{var}_1(\cdot) \) denotes the variance conditional on Time 1 information. Applying formulas for normal random variables gives:

\[
E_1[\max\{0, p_1 - E_2[v]\}] = \Phi\left(\frac{p_1 - E_1[v]}{\text{std}_1(E_2[v])}\right)(p_1 - E_1[v]) + \text{std}_1(E_2[v]) \phi\left(\frac{p_1 - E_1[v]}{\text{std}_1(E_2[v])}\right), \tag{A.8}
\]

where \( \Phi \) and \( \phi \) denote the distribution and density for standard normal random variables. Substituting (A.8) into (A.7) and rearranging shows that \( p_1 \) satisfies:

\[
g(\hat{k}) \equiv \left(1 + \frac{\theta \gamma \alpha}{1 - \theta \gamma} \phi(-\hat{k})\right) \hat{k} - \frac{\theta \gamma \alpha}{1 - \theta \gamma} \phi(\hat{k}) = 0, \quad \hat{k} \equiv \frac{E_1[v] - p_1}{\text{std}_1(E_2[v])}. \tag{A.9}
\]

The function \( g(\hat{k}) \) is continuous and strictly increasing in \( \hat{k} \).\(^{16}\) It approaches \(-\infty\) as \( \hat{k} \to -\infty \) and approaches \( \infty \) as \( \hat{k} \to \infty \) so that a \( \hat{k} \in (-\infty, \infty) \) solves \( g(\hat{k}) = 0 \). Define the function \( k(\theta \gamma, \alpha) \) as the value of \( k \) that solves \( g(k) = 0 \). Because \( g(0) = -\frac{\theta \gamma \alpha}{1 - \theta \gamma} \sqrt{2\pi} < 0 \), \( k \) must be strictly positive. Furthermore, \( k \) depends only on \( \theta \gamma \) and \( \alpha \). The definition of \( \hat{k} \) implies that the equilibrium price \( p_1 \) has the form given by (7b). \( \blacksquare \)

**Proof of Corollary 3**

Direct computations using the definition of \( g(\hat{k}) \) in (A.9) and the condition \( g(k) = 0 \) give the following, where the computations of \( \partial g/\partial \theta \gamma \) and \( \partial g/\partial \alpha \) use substitutions from

\(^{16}\)Using \( \phi'(\hat{k}) = -\hat{k} \phi(\hat{k}) \) and \( \phi(\hat{k}) = \phi(-\hat{k}) \) implies that \( g'(\hat{k}) = 1 + \frac{\theta \gamma \alpha}{1 - \theta \gamma} \phi(-\hat{k}) > 0 \).
\( g(k) = 0: \)

\[
\begin{align*}
\frac{\partial g}{\partial k} &= 1 + \frac{\theta_\gamma \alpha}{1 - \theta_\gamma} \Phi(-k) > 0 \\
\frac{\partial g}{\partial \theta_\gamma} &= -\frac{1}{\theta_\gamma} \frac{1}{1 - \theta_\gamma} k < 0 \\
\frac{\partial g}{\partial \alpha} &= -\frac{1}{\alpha} k < 0. \quad (A.10)
\end{align*}
\]

Corollary 3 follows from the implicit function theorem using (A.10) because \( \frac{\partial k}{\partial \theta_\gamma} = -\frac{\partial g/\partial \theta_\gamma}{\partial g/\partial k} \) and \( \frac{\partial k}{\partial \alpha} = -\frac{\partial g/\partial \alpha}{\partial g/\partial k} \).

\[ \blacksquare \]

**Proof of Proposition 4**

Expression (8) gives the Time 1 and 2 prices. Substituting the Time 2 price into the Time 1 price, computing expectations conditional on Time 1 information and rearranging gives the condition:

\[
\begin{align*}
g_2(\hat{k}_2) &\equiv \left( \theta_\gamma (1 - \alpha) \Phi\left( \frac{1 - \alpha}{\alpha} \hat{k}_2 \right) - 1 \right) \hat{k}_2 + \theta_\gamma \alpha \phi\left( \frac{1 - \alpha}{\alpha} \hat{k}_2 \right) = 0, \\
\hat{k}_2 &\equiv \frac{\alpha}{1 - \alpha} \frac{p_1 - E_1[v] + x}{\text{std}_1(E_2[v])},
\end{align*}
\]

where

\[
g'_2 = -\left( 1 - \theta_\gamma (1 - \alpha) \Phi\left( \frac{1 - \alpha}{\alpha} \hat{k}_2 \right) \right) < 0, \quad (A.12)
\]

and \( g_2(0) = \theta_\gamma \alpha \phi(0) > 0 \) so that the \( \hat{k}_2 \) that solves \( g_2(\hat{k}_2) = 0 \) is positive. Substituting back into the definition of \( \hat{k}_2 \) in (A.11) gives \( p_1 = E_1[v] - x + \frac{1 - \alpha}{\alpha} k_2 \text{std}_1(E_2[v]) \).

Now consider the insurance premium \( x \), which is set so that insurers breakeven:

\[
\begin{align*}
x &= E[\theta_\gamma \max\{0, p_1 - p_2\}] = \theta_\gamma E \left[ \max\{0, E_1[v] + \frac{1 - \alpha}{\alpha} k_2 \text{std}_1(E_2[v])\} \right] \quad (A.13) \\
&= \frac{1}{\alpha} k_2 \text{std}_1(E_2[v]). \quad (A.14)
\end{align*}
\]

Substituting back into \( p_1 \) gives the prices (9b).
Proof of Corollary 5

Direct computation using the definition \((A.11)\) of \(g_2\) give:

\[
\frac{\partial g_2}{\partial \theta \gamma} = \left( \frac{1-\alpha}{\alpha} k_2 + \frac{\phi(\frac{1-\alpha}{\alpha} k_2)}{\Phi(\frac{1-\alpha}{\alpha} k_2)} \right) \Phi(\frac{1-\alpha}{\alpha} k_2) \alpha > 0 \quad (A.15)
\]

\[
\frac{\partial g_2}{\partial \alpha} = \frac{1}{\alpha} \left( 1 - \theta \gamma \Phi(\frac{1-\alpha}{\alpha} k_2) \right) k_2 > 0 \text{ for } k_2 > 0, \quad (A.16)
\]

where the inequality \(\frac{\partial g_2}{\partial \theta \gamma} > 0\) follows from the fact that the function \(x + \frac{\phi(x)}{\Phi(x)}\) is strictly positive (Einhorn 2005). The claims that \(\frac{dk_2}{d\theta \gamma} > 0\) and \(\frac{dk_2}{d\alpha}\) follow from the implicit function theorem since \(\frac{\partial g_2}{\partial k_2} < 0\). The claims that \(k_2(\theta \gamma = , \alpha) = k_2(\theta \gamma, \alpha = 0) = 0\) follows from substituting into \(g_2\), given in (A.11). Because \(k_2\) is increasing in both \(\theta \gamma\) and \(\alpha\), substituting the maximum values of \(\theta \gamma = 1\) and \(\alpha = 1\) into \(g_2\) gives the upper bound of \(\phi(0)\). The claim that \(k_2 < k\) follows from inspection of Figure 5. ■

Proof of Corollary 6

The difference in litigation probabilities follows from the fact that \(\Phi\) is strictly increasing since \(\frac{1-\alpha}{\alpha} k_2 > 0 > -k\).

When the firm has insurance, the changes in litigation probabilities are:

\[
\frac{d\Phi(\frac{1-\alpha}{\alpha} k_2)}{d\theta \gamma} = \phi \left( \frac{1 - \alpha}{\alpha} k_2 \right) \frac{1 - \alpha}{\alpha} \frac{dk_2}{d\theta \gamma} > 0 \quad (A.17a)
\]

\[
\frac{d\Phi(\frac{1-\alpha}{\alpha} k_2)}{d\alpha} = \phi \left( \frac{1 - \alpha}{\alpha} k_2 \right) \left( \frac{1 - \alpha}{\alpha} \frac{dk_2}{d\alpha} - \frac{1}{\alpha^2} k_2 \right) = -\frac{1}{\alpha} \phi \left( \frac{1 - \alpha}{\alpha} k_2 \right) \frac{1}{1 - \theta \gamma (1 - \alpha)} \Phi(\frac{1-\alpha}{\alpha} k_2) k_2 < 0 \text{ for } k_2 > 0. \quad (A.17b)
\]

When the firm has no insurance, the changes in litigation probabilities are:

\[
\frac{d\Phi(-k)}{d\theta \gamma} = -\phi(k) \frac{dk}{d\theta \gamma} < 0 \quad \text{and} \quad \frac{d\Phi(-k)}{d\alpha} = -\phi(k) \frac{dk}{d\alpha} < 0. \quad (A.18)
\]

■
Proof of Corollary 7

The first statement, that $p_1$ is decreasing in $\text{std}_1(E_2[v])$, follows directly from Proposition 2. For the claim that the expected price return is decreasing in $\text{std}_1(E_2[v])$, first compute:

$$E[p_2] = E[E_1[p_2]] = E \left[ E_1[v] - \frac{\theta \gamma}{1 - \theta \gamma} E_1 \left[ \max\{0, p_1 - E_2[v]\} \right] \right].$$

(A.19)

Because, given Time 1 information, $E_2[v] \sim \mathcal{N}(E_1[v], \text{var}(E_2[v]))$, we have:

$$E_1 \left[ \max\{0, p_1 - E_2[v]\} \right] = E_1 \left[ 1_{E_2[v] < p_1} (p_1 - E_2[v]) \right] = \frac{1 - \theta \gamma}{\theta \gamma \alpha} \text{std}_1(E_2[v])k;$$

(A.20)

where the second line follows from using (A.9) to substitute for $g(k) = 0$. This gives $E_1[p_2] = E_1[v] - \frac{1}{\alpha} k \text{std}_1(E_2[v])$ which, in conjunction with (7b) implies (10).

Proof of Proposition 9

Given the investors’ conjecture of the manager’s strategy in (13), the expected value $E_2[v]$ is normally distributed given the Time 1 information $(\hat{r}, y)$ so that Proposition 2 applies. Given the linear conjectures, the conditional expectation $E_1[v]$ is:

$$E[v | \hat{r}, y] = E[v | y] + \frac{\text{cov}(v, \hat{r}|y)}{\text{var}(\hat{r}|y)} (\hat{r} - \hat{r}_0 - \hat{r}_r E[y | r] - \hat{r}_x \mu_x).$$

(A.21)

Given the manager’s conjecture in (13), his objective function is:

$$\max_{\hat{r}} x(E[E[v|\hat{r}, y]|r] + \hat{k}_0 + \hat{k}_r \hat{r} + \hat{k}_y E[y|r]) - \frac{C}{2} (\hat{r} - r)^2;$$

(A.22)

and solving the first order condition gives:

$$\hat{r} = r + x \frac{1}{c} \left( \frac{\text{cov}(v, \hat{r}|y)}{\text{var}(\hat{r}|y)} + \hat{k}_r \right).$$

(A.23)

Solving for coefficients gives $\hat{k}_r = \hat{k}_y \hat{r}_0 = 0$ and $+\hat{r}_r = 1$. The coefficient $-\hat{k}_0$ equals the value $k \text{std}_1(E_2[v])$ determined by the relation (A.9), which does not depend on
the manager’s report but does depend on his strategy via the term \( \text{std}_1(E_2[v]) = \sqrt{\text{var}(E[v]^r, y, s | \hat{r}, y)} \). The equilibrium is determined by solving the following equation:

\[
\frac{r_x}{c} = \frac{1}{c \text{ var}(\hat{r}|y)} = \frac{1}{c \text{ var}(r|y) + r^2 \tau_x^{-1}}. \tag{A.24}
\]

Rearranging (A.25) gives the cubic (14c), which is increasing in \( r_x \) and is negative for \( r_x = 0 \) because \( \text{corr}(e_r, e_y) = \rho_{ry} < \tau_y/\tau_r \) implies \( \text{cov}(v, r|y) = \frac{1 - \rho_{ry} \sqrt{\tau_y/\tau_r}}{\tau_v + \tau_y} > 0 \), so that \( r_x \) must be positive. The upper bound of \( 1/c \) on \( r_x \) follows because setting \( r_x = 1/c \) in (14c) gives:

\[
\frac{1}{c^3} + \frac{\tau_x}{c} (\text{var}(r|y) - \text{cov}(v, r|y)) = \frac{1}{c^3} + \frac{\tau_x}{\tau_r} \frac{1 - \rho_{ry}^2}{\tau_v + \tau_y} + \sqrt{\frac{\tau_y}{\tau_r}} \left( \sqrt{\frac{\tau_y}{\tau_r}} - \rho_{ry} \right) > 0, \tag{A.25}
\]

where the inequality follows from \( \rho_{ry} = \text{corr}(e_r, e_y) < \sqrt{\tau_y/\tau_r} \) and implies that \( r_x < 1/c \).
Figures

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Firm’s inception
Manager reports \( \hat{r} \), Time 1
\( \hat{r} \), Time 1
investors buy at price \( p_1 \)

Signal released, Time 2
investors buy at price \( p_2 \)

Terminal dividend \( v \) realized, if Time 1
investors sue, firm pays \( \gamma \max\{0, p_1 - p_2\} \)

Time 1 investors receive \( \gamma (1 - \alpha) \max\{0, p_1 - p_2\} \)

Figure 1: Timeline
Figure 2: Time 2 price $p_2$ as a function of $E_2[v]$

Figure 2 the Time 2 price $p_2$ as a function of $E_2[v]$ under the assumption that the expected damage proportion $E_2[\theta_\gamma]$ is decreasing and concave in $E_2[v]$, where $\theta$ denotes the probability of losing a lawsuit and $\gamma$ denotes the magnitude of the price drop $\max\{0, p_1 - p_2\}$ paid in the event of a successful suit.
Figure 3: Threshold of conjectured lawsuit participation $\pi$ as a function of ownership $\eta$

Figure 3 displays the conjectured proportion $\pi = \frac{1-\eta-\alpha}{1-\eta}$ of shares that will participate in a lawsuit conditional on filing. An investor who owns portion $\eta$ of shares will find it profitable to initiate a lawsuit if he believes that other shareholders owning less than portion $\pi$ will participate in the lawsuit. The figure plots the curve $\pi$ for different levels of transaction costs $\alpha$. 
Figure 4: Time 2 price and expected damages as a function of $E_2[v]$

Figure 4 the Time 2 price $p_2$ and expected damages $\theta \gamma \max\{0, p_1 - p_2\}$ as a function of the Time 2 expected value $E_2[v]$. The thin lines denote the case when the firm has insurance and the thin lines denote the case when the firm has no insurance. The point $E_a$ denotes the value of $E_2[v]$ below (above) which the expected damages are greater (lower) when the firm has no insurance. The points $E_b$ and $E_c$ denote the minimum values of $E_2[v]$ for which investors sue in the no-insurance and insurance cases, respectively.
Figure 5: Litigation cost functions without insurance $k(\theta \gamma, \alpha)$ and with $k_2(\theta \gamma, \alpha)$

Figure 5 plots the litigation cost functions without insurance $k(\theta \gamma, \alpha)$ and with $k_2(\theta \gamma, \alpha)$ from the prices (7b) and (9b), respectively. The dark gray surface plots costs $k$ without insurance and the light gray surface plots costs $k_2$ with insurance for all possible values of $\theta \gamma$ and $\alpha$. 