A nonlinear wealth transfer from shareholders to creditors around Chapter 11 filing

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A B S T R A C T

Past literature has assumed that negative stock returns around Chapter 11 filing are solely due to new adverse information about firm value. This paper argues that there is also a nonlinear wealth transfer from shareholders to creditors causing shareholder loss. The magnitude of the wealth transfer can be quantified in a setting where equity is a call option on firm assets as in the Merton (1974) model. The wealth transfer originates from maturity shortening of the call option as a result of Chapter 11 filing. I present a parsimonious model to explain why Chapter 11 can be voluntarily filed by managers acting in the interest of shareholders with the existence of the wealth transfer. The model-predicted stock return has comparable magnitude as observed stock returns around filing, and explains the cross-sectional variation of the latter.

1. Introduction

Chapter 11 filing is an extremely negative event for shareholders in as short as a few days. Past literature documents that shareholders on average lose about 30% of their stock value around filing time (see Altman, 1971; Lang and Stulz, 1992). The large magnitude of negative stock returns has been interpreted as evidence that filing reveals significant amounts of new adverse information about firm value. For example, Datta and Iskandar-Datta (1995) state "Bankruptcy filing conveys information about the cash flow prospects of the firm leading to a reassessment of the true value of its assets". While acknowledging new information about firm value is one of the factors causing negative stock returns around filing, I argue that theoretically, there is also a nonlinear wealth transfer from shareholders to creditors as a result of filing.

To understand why there is a wealth transfer from shareholders to creditors, it is important to know how Chapter 11 works. Chapter 11 bankruptcy is a form of corporate financial reorganization, which typically allows companies to continue to function while they follow debt repayment plans. From the definition it is obvious there are two fundamental elements of the Chapter 11 process. First, the firm continues its business; second, all debt needs to be paid off. Shareholders will only receive payoffs if the firm value turns out to be higher than the value of all debt at the time of forming a reorganization plan. Without Chapter 11 filing, the firm only needs to be paid off. Shareholders will only receive payoffs if the firm value turns out to be higher than the value of all debt at the time of forming a reorganization plan. Without Chapter 11 filing, the firm only needs to be paid off. Shareholders will only receive payoffs if the firm value turns out to be higher than the value of all debt at the time of forming a reorganization plan. Without Chapter 11 filing, the firm only needs to be paid off. Shareholders will only receive payoffs if the firm value turns out to be higher than the value of all debt at the time of forming a reorganization plan. Without Chapter 11 filing, the firm only needs to be paid off. Shareholders will only receive payoffs if the firm value turns out to be higher than the value of all debt at the time of forming a reorganization plan. Without Chapter 11 filing, the firm only needs to be paid off. Shareholders will only receive payoffs if the firm value turns out to be higher than the value of all debt at the time of forming a reorganization plan.

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loss even if filing does not convey any new adverse information about firm value.

The magnitude of the wealth transfer can be quantified in a setting where equity is a call option on firm assets as in Merton (1974) model. When a distressed firm does not file for Chapter 11, shareholders have a chance to turn around the firm until the due date of the debt. Without any anticipation of filing, equity can be valued as a call option whose maturity depends on the structure of remaining debt maturities. Once Chapter 11 is filed, equity value is equal to a new call option value with a maturity that is the expected time period from filing to the point when a reorganization plan is formed and submitted to the court. This time period is shorter than the original remaining debt maturity. Thus, with everything else equal, equity value becomes lower after filing. Normally the management remains in control after filing and has 120 days of exclusivity to submit a reorganization plan, and another 60 days to solicit approval for the plan. After the expiration of the 180-day period, any interested party including creditors can submit a reorganization plan. Although the court sometimes extends the exclusivity period, to the extent that reorganization plans submitted later or by creditors are less lenient to shareholders, the 180-day period can be viewed as a period when shareholders can extract any value if the option pays off. Therefore, the equity value after filing is equal to an option value whose maturity is around 180 days (0.5 years). When filing is anticipated to some extent, pre-filing equity value is a probability weighted average of the high and low option value, and the post-filing equity value is just the low option value. To capture how much stock prices should drop due to the wealth transfer from shareholders to creditors, I estimate explicitly the degree of anticipation and the two option values using the option formula in Black and Scholes (1973).

The wealth transfer effect of filing naturally explains the existence of involuntary Chapter 11 filings: cases filed by creditors. One puzzle is why we observe voluntary Chapter 11 filings by managers whose interests are aligned with shareholders. I present a parsimonious model to answer this question. In the model, only managers know the true firm value and make the decision about whether to file for bankruptcy in the interest of shareholders. For shareholders, Chapter 11 comes with both benefits and costs. The benefit originates from the automatic stay feature of the Chapter 11 process. Once a firm files for Chapter 11, the court prohibits all creditors from taking action against the firm pending an approval of a reorganization plan by the court. This gives the firm temporary relief from collection attempts, lawsuits, and foreclosure procedures. The cost of filing is generated by the nonlinear wealth transfer from shareholders to creditors explained above. The benefits of filing are significantly higher for low-value firms than high-value firms, while the costs are the same. In equilibrium, all low-value firms file for Chapter 11 voluntarily and high-value firms do not file. Thus, filing reveals the true firm value to shareholders through a “signaling” effect and generates the nonlinear wealth transfer. The model not only captures the nonlinear wealth transfer effect, but also formally addresses how new adverse information is incorporated into share prices around filing in a theoretical framework. In reality, we observe both voluntary and involuntary filings. Although involuntary filings are not formally modeled in this paper, the effect of filing on stock value remains the same. New adverse information about firm value and the wealth transfer from shareholders to creditors are still the two main forces driving stock prices downward.

My model is related to other theory work in the bankruptcy literature. Several papers also evaluate claims on bankrupt firms in an option framework. Bebchuk (1988, 2000) proposes a new method of dividing the reorganization pie among claim-holders in the Chapter 11 reorganization process by issuing tradable options, replacing the current bargaining process. He argues that when the true firm value is unknown, bargaining is inefficient. However, the value of all claims on the bankrupt firm can be synthesized using options with different strike prices, regardless of the true firm value. Bebchuk and Chang (1992) develop a sequential bargaining model of the negotiations between shareholders and creditors within Chapter 11. Shareholders have incentives to delay the reorganization process to prolong the option maturity they have on firm assets, while delayed reorganization can hurt overall firm value due to additional financial distress costs. In equilibrium, creditors are willing to sacrifice some of their claims for shareholders to achieve faster reorganization resolution. The argument is empirically supported by Franks and Torous (1994), who find that Chapter 11 reorganizations have lower equity deviations from absolute priority and lower creditor recovery rates, compared to out-of-court exchange offers. Russel, Branch, and Torbay (1999) use Black and Scholes (1973) formula to evaluate post-filing bankrupt stocks and find that overall, they are not overpriced. My paper adds to the theory literature on bankruptcy by modeling two aspects of voluntary Chapter 11 filing: new adverse information is revealed to the market through a “signaling” effect given that filing is only the optimal choice of low-value firms; there exists a nonlinear wealth transfer from shareholders to creditors as a result of filing, which alone can cause shareholder loss. To my knowledge, this paper is the first in the literature unifying these two effects in one simple model. Additionally, I use the model to explain abnormal stock returns around Chapter 11 filing with an empirical analysis.

The empirical results are summarized as follows. Sample average elasticities of the option value with respect to the change of the option maturity and firm value are 0.68 and 2.43, respectively. The sample average of option maturity shortening is −70%. Thus, a 70% drop in the option maturity causes the option value to decrease 48%; a 10% reduction in firm value generates a 24% decrease in the option value. The large magnitude of the decrease in the option value due to maturity shortening alone is interesting. The average total change of the option value through these two channels is −63%. Accounting for an average 28% for investors’ perceived filing probability, the model-predicted stock return has a mean of −54%. The model successfully captures the mean
level of shareholder loss around filing. The cross-sectional variation in observed stock returns can also be explained by model-predicted stock returns. A one standard deviation change in the model-predicted stock return is associated with an additional shareholder loss of 7%. This paper contributes to the literature related to distress and bankruptcy in several ways. First, the model adds to the theory work on bankruptcy by formally modeling the endogenous Chapter 11 filing decision and its price impact on shares. I show how new adverse information is incorporated into share prices and capture the nonlinear wealth transfer from shareholders to creditors as a result of filing. Second, I contribute to the literature investigating share price behavior around Chapter 11 filing, which has been a main line of work in empirical bankruptcy studies. The model is used to explain empirically the average magnitude of shareholder loss around filing and its cross-sectional variation. I show that the magnitude of surprise in the Chapter 11 filing news, option maturity shortening, and the underlying firm value reduction simultaneously determine the magnitude of shareholder loss. This helps deepen our understanding about price patterns of bankrupt stocks. Lastly, this paper also has implications for efficiency issues of the Chapter 11 process. The model implies that a prolonged Chapter 11 duration is not only inefficient ex post with higher professional fees paid to lawyers and auditors, but also inefficient ex ante. For shareholders, when they expect the firm to stay in Chapter 11 for a longer period of time, the cost of filing is lower with the embedded call option on firm assets. This increases the chance of moral hazard in excessive risk taking by shareholders ex ante. Indeed, the US bankruptcy law has been viewed as more debtor-friendly because firms are allowed to stay in Chapter 11 for a longer period than their peers in other countries.

The paper is organized as follows: Section 2 gives a brief literature review of related empirical bankruptcy studies; Section 3 develops the model of endogenous Chapter 11 filing in an option framework; Section 4 explains how I construct regression equations and variables to test the model, and describes the sample; Section 5 presents empirical results of hypothesis testing using daily stock returns around filing and conducts robustness checks; Section 6 discusses the results; Section 7 concludes.

2. Related empirical research on bankruptcy

The paper is related to three areas of research on bankruptcy: the news impact of bankruptcy filing, bankruptcy costs, and the prediction of bankruptcy filing.

The negative price impact of Chapter 11 filing is shown in several studies. Altman (1971) finds that shareholders suffer a loss of 26% from one month before to one month after the filing date. Clark and Weinstein (1983) document the negative filing effect prior to the 1978 Bankruptcy Reform Act. Shareholders lose 47% on average in the three-day event window. They conclude that bankruptcy filing, starting from Beaver (1968) and Altman (1968), through Ohlson (1980) and Zmijewski (1984), to Shumway (2001) and Chava and Jarrow (2004). The majority of these studies focus on enhancing the statistical methodology and/or expanding the set of explanatory variables with the goal of improving prediction accuracy. The purpose is to calculate the probability of filing with a forecast period of one year. Many of these have used composite measures that statistically combine several accounting variables, with Altman’s (1968) Z-Score and Ohlson’s (1980) O-Score being the most popular. In particular, Altman (1968) uses the multiple discriminant analysis methodology to compare a bankrupt sample with a matching sample, deriving a linear combination of firm characteristics that “best” discriminate between the two groups. Ohlson (1980) uses a conditional Logit model to estimate a sample containing bankrupt firms and all non-bankrupt firms from Compustat. Zmijewski (1984) criticizes previous research about the non-random sampling problem that creates estimation bias. Shumway (2001) solves this problem with a discrete-time sampling model, which is equivalent to a dynamic conditional Logit model. The hazard model uses all available information to determine bankruptcy risk instead of only the information from one year before filing.

3. The model of endogenous Chapter 11 filing

3.1. The nonlinear wealth transfer from shareholders to creditors around filing

The nonlinear wealth transfer is generated by maturity shortening of the call option shareholders have on firm assets. To compute the option value, I follow the setting in Merton (1974). Firm value at time \( t \), \( V_t \), is assumed to follow a standard diffusion process

\[
dV_t/V_t = (\alpha - D) dt + \sigma dW_t,
\]

where \( \alpha \) is the drift, \( D \) is the dividend yield, \( \sigma \) is the volatility, and \( W_t \) is a standard Brownian motion. The nonlinear wealth transfer is generated by maturity shortening of the call option shareholders have on firm assets. To compute the option value, I follow the setting in Merton (1974). Firm value at time \( t \), \( V_t \), is assumed to follow a standard diffusion process

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\[
dV_t/V_t = (\alpha - D) dt + \sigma dW_t,
\]
where \( x \) is the instantaneous expected rate of return on firm value per unit of time; \( D \) is the total dollar payout by the firm per unit time to its shareholders and creditors; \( \sigma^2 \) is the instantaneous variance of the return on firm value per unit time; \( dW_t \) is the standard Gauss-Wiener process.

Merton (1974) shows that when a firm’s debt is a zero-coupon bond, the equity value as a contingent claim on firm value \( V \), can be solved using Black and Scholes (1973) model. The underlying value process is the firm value process, and the strike price is the face value of debt. For distressed firms, it is reasonable to assume that there is no payout to either shareholders or creditors: \( D = 0 \). Denote the equity value by \( E \). Thus, I use the simple option formula in Black and Scholes (1973)

\[
E = C(V,X,r,T,\sigma^2) = VN(d_1) - Xe^{-rT}N(d_2),
\]

\[
d_1 = \frac{\ln(V/X) + (r + \sigma^2/2)T}{\sigma\sqrt{T}},
\]

\[
d_2 = d_1 - \sigma\sqrt{T},
\]

where \( V \) is the current firm value; \( X \) is the strike price of the call option, which is the face value of debt; \( \sigma^2 \) is the instantaneous variance of the return on firm assets; \( r \) is the risk-free rate; and \( T \) is the maturity of the option, i.e., the time length that the firm has to meet its debt obligations.

When a firm has multiple debt obligations with different maturities and is not expected to file for Chapter 11, equity value should be equal to the value of a compound call option as shown in Geske (1977). For simplicity, I approximate the compound call option value with a simple call option value calculated using the Black-Scholes formula. The maturity of the option is equal to the average debt maturity weighted by the face value of each debt obligation. I acknowledge that using the Merton (1974) model is not as accurate as alternative corporate bond models such as Geske (1977). However, with a single maturity variable for the whole debt structure, I can study directly the impact of maturity shortening on the option value. The Merton (1974) model effectively conveys the intuition. Denote the average debt maturity by \( T_1 \). For a firm that is not expected to file for Chapter 11, equity value is equal to \( C(V,X,r,T_1,\sigma^2) \).

Chapter 11 filing shortens the maturity of the option shareholders have on firm assets. Once Chapter 11 is filed, all creditors need to be paid off in the reorganization process before shareholders receive any payments.\(^1\) Creditors can be paid with cash or new claims on firm assets such as new debt or new equity. Regardless of the form the payment might take, equity right after filing should be valued as a simple call option: its maturity is the expected time period from filing to the time when a reorganization plan is formed and submitted to the court. At the time of filing, the actual value of this time period is unknown, and thus is a random variable. Denote the expected value of this duration as \( T_2 \). Equity value right after filing is equal to \( C(V,X,r,T_2,\sigma^2) \).

In summary, equity value can be calculated using the Black-Scholes formula and Chapter 11 filing shortens the option maturity: without any anticipation of Chapter 11 filing, equity value is \( C(V,X,r,T_1,\sigma^2) \); right after Chapter 11 filing, equity value is equal to \( C(V,X,r,T_2,\sigma^2) \). When \( r \), \( \sigma^2 \), and \( X \) remain unchanged, I simplify the notations for equity value by \( C(V,T_1) \) and \( C(V,T_2) \), respectively.\(^2\) Since all creditors get paid in Chapter 11, while without Chapter 11 filing firms only need to pay off debt that is due, we have \( T_1 > T_2 \). Total value of the nonlinear wealth transfer from shareholders to creditors by accelerated debt payments is \( C(V,T_1) - C(V,T_2) \). This part of the shareholder loss holds even if filing conveys no new information about the true firm value \( V \).

The wealth transfer effect described above is inherent in the action of filing regardless of its reason or form. Chapter 11 can be filed by creditors (involuntary filings) or by managers with the support of the board of directors (voluntary filings). With the existence of wealth transfer from shareholders to creditors, it is obvious why creditors push for Chapter 11 filing when the firm is in deep distress. It seems puzzling why managers acting in the interest of shareholders can choose to file voluntarily. This is because Chapter 11 filing also provides benefits to financially struggling debtors. Once Chapter 11 is filed, an automatic stay goes into effect. The automatic stay “stops the clock”, giving the debtor some time to get back on its financial feet. The court prohibits all creditors from taking actions against the firm pending an approval of a reorganization plan by the court. This gives the firm temporary relief from collection attempts, lawsuits, and foreclosure procedures. Chapter 11 filing also allows debtors to borrow new debt under the “Debtor-in-Possession” provision (DIP financing). Without filing, new financing is extremely hard to get for distressed firms. When the benefits outweigh the costs of filing (wealth transfer to creditors) for shareholders, voluntary filing is the optimal and rational choice of the management who acts in the interest of shareholders.

In the following section, I present a parsimonious model to address this issue and solve for the value effect of Chapter 11 filing on share prices.

3.2. Endogenous Chapter 11 filing

There are three dates \( t = 0, 1, 2 \) in the model, as shown in Fig. 1. Equity value at date 0 and date 1 are denoted by \( E^0 \) and \( E^1 \), respectively. I make the following assumptions:

(i) investors are risk-neutral, and the risk-free rate is zero when shareholders compute the equity value at date 0 and date 1;

\(^1\) When the Absolute Priority Rule (APR) is violated, shareholders receive payoffs before all creditors get paid in full. Bharath, Panagopoulass, and Werner (2010) show that the frequency and magnitude of APR violations are significantly lower for US bankrupt firms after 2000. Thus, I regard the model an approximation to reality by assuming no APR violation for sample firms. This is a reasonable assumption given that APR violation is an ex post result of renegotiation between shareholders and creditors, but not necessarily an ex ante expectation. While fully modeling the bargaining process between shareholders and creditors within Chapter 11 is beyond the scope of this paper, interested readers can refer to Bebchuk and Chang (1992) on this topic.

\(^2\) While the interest rate \( r \) and total liabilities \( X \) are unlikely to change from pre-filing to post-filing time, the underlying firm business risk \( \sigma^2 \) might be subject to change. Assuming constant \( \sigma^2 \) is a restrictive assumption. This will be discussed in greater detail in Section 6.1.
Shareholders have a prior distribution of firm value $V$. Shareholders are aware of the decision process of managers regarding Chapter 11 filings at $t=1$. Equity value is calculated based on the prior distribution of firm value $V$.

Managers need to make a decision to file for Chapter 11 or not. Shareholders observe whether Chapter 11 is filed and equity value is re-calculated. If Chapter 11 is filed, the timeline ends here; if Chapter 11 is not filed, the timeline continues to $t=2$.

The firm files for Chapter 11. Equity value is equal to $C(V,T_1)$.

The firm does not file for Chapter 11. Equity value is equal to expected value from $t=2$.

Managers make an optimal decision whether to file for Chapter 11 by maximizing equity value at $t=1$.

The firm is liquidated with probability $q(V)$, shareholders get zero.

The firm survives with probability $1-q(V)$, equity value is equal to $C(V,T_2)$.

(ii) from date 0 to date 2, firm asset volatility $\sigma$, face value of all liabilities $X$, and the risk-free rate $r$ remain unchanged;

(iii) managers act in the interest of shareholders, with a goal to maximize shareholder value.

Given that Chapter 11 is a significant news event, there cannot exist perfect information between managers and the financial market. I introduce information asymmetry between managers and shareholders regarding the true firm value. At date 0, shareholders do not know the exact firm value $V$ but have a prior of its distribution $V \sim U(a,b)$, which is a uniform distribution on the interval $[a,b]$. Managers have perfect information about $V$. At date 1, managers need to decide whether to file for Chapter 11. Upon observing whether Chapter 11 is filed at date 1, shareholders update their belief about firm value $V$ and price their shares accordingly.

If managers choose not to file for Chapter 11 at date 1, at date 2 the firm does not gain the “automatic stay” status provided by the Chapter 11 bankruptcy protection. Shareholders face a possibility of adverse actions taken by creditors or other interested groups. For example, creditors can demand the firm be liquidated, or lease suppliers can start foreclosures on core firm assets. Nevertheless, I name such an adverse state as a “liquidation” state to simplify the notation. In this liquidation state, shareholders receive zero. The probability of liquidation at date 2 is a function of firm value $V$: $q = q(V)$. The function $q(\cdot)$ satisfies the following conditions: $q(0) = 1$, $q'(0) = 0$, $q'(\infty) = 0$, $\lim_{V \to -\infty} q(V) = 0$, and $q(\cdot) \leq 0$. It is plotted against firm value in Fig. 2. The probability of liquidation decreases as firm value increases. Intuitively, the chance for creditors or lease suppliers to take adverse actions becomes smaller when the firm has better quality.

The probability for the firm to survive at date 2 is $1 - q(V)$. Once the firm survives, equity value is equal to a call option $C(V,T_1)$ as shown in Section 3.1, where $T_1$ is the remaining average debt maturity. Thus, if managers choose not to file for Chapter 11 at date 1, shareholder value at date 1, $E_1^1$, is given by the following diagram:

$$E_1^1 = \begin{cases} 0 & \text{with probability } q(V), \\ C(V,T_1) & \text{with probability } 1-q(V). \end{cases}$$

By expected value calculation: $E_1^1 = (1-q(V)) \cdot C(V,T_1)$.

If managers choose to file for Chapter 11 at date 1, the timeline ends here and there is no date 2. The firm starts the reorganization process within Chapter 11 while continuing its business activities. As explained in Section 3.1, equity value at date 1 is a simple call option value $E_2^1 = C(V,T_2)$, where $T_2$ is the expected Chapter 11 duration. Since managers have perfect information about firm value $V$ and they act in the interest of shareholders, their decision regarding Chapter 11 filing maximizes shareholder value at date 1 such that $E_1^1 = \max(E_1^1,E_2^1)$. The decision outcome depends on the true firm value $V$, as described by the following proposition:

**Proposition 1.** When $q = q(V)$ satisfies $q(0) = 1$, $q'(0) = 0$, $q'(\infty) = 0$, $\lim_{V \to -\infty} q(V) = 0$, and $q(\cdot) \leq 0$:

1. If $T_1 > T_2$, there exists a threshold $V^* > 0$ such that $E_1^1 = E_2^1$. For any firm value $V > V^*$, managers choose not to file for Chapter 11 at date 1; for any firm value $V < V^*$, managers choose to file at date 1.
2. If $T_1 < T_2$, managers always choose to file for Chapter 11 at date 1.

Proof. See Appendix.

Intuitively, if $T_1 > T_2$, the call option value with filing $C(V, T_2)$ is less than the call option value without filing $C(V, T_1)$. Filing accelerates payments to creditors generating a nonlinear wealth transfer from shareholders to creditors. Therefore, managers always want to continue without filing if they can. However, if they do not file for Chapter 11 now, there is a chance of liquidation which leaves shareholders with nothing later. It forms a trade-off between filing for Chapter 11 or not at date 1. Additionally, this chance of liquidation increases when firm value $V$ decreases. Low-value firms have a slim chance of survival without filing, so they optimally choose to file. In their cases, $C(V, T_2) > (1-q(V))C(V, T_1)$. For high-value firms, the chance of being liquidated is not large enough to encourage filing at date 1: $C(V, T_2) < (1-q(V))C(V, T_1)$. If $T_1 < T_2$, all firms choose to file for Chapter 11 because filing not only gives shareholders a higher call option value with more time, but also prevents the liquidation state. This is a trivial scenario and is not consistent with empirical observations, so it is not included in the analysis.

With $T_1 > T_2$, Chapter 11 filing generates negative price reactions because filing shortens the maturity of the option shareholders have on firm assets, and reveals new adverse information about the true firm value through a "signaling" effect.

Proposition 2. Assume ex ante at date 0, shareholders are aware of the decision process of managers at date 1 and they have complete information about $T_1, T_2$, and the function form of $q(V)$. When $T_1 > T_2$:

1. At date 0, investors’ perceived Chapter 11 filing probability $p$ is implied from their prior about the distribution of firm value $V$: $p = (V^* - a)/(b - a)$.
2. There is a negative price reaction to Chapter 11 filing and the stock return around filing is $R = (E^1 - E^0)/E^0 < 0$, where $E^0$ is the equity value at time 0

$$E^0 = \int_a^{b} \frac{1}{b-a} [(1-q(V)) \cdot C(V, T_1)] dV + \int_a^{V^*} \frac{1}{b-a} C(V, T_2) dV,$$
and \( E^1 \) is the equity value at time 1
\[
E^1 = \int_a^b 1 \frac{1}{b-a}C(V, T_2) \, dV.
\]

Proof. See Appendix.

To facilitate the empirical testing, I simplify shareholders’ prior about the distribution of firm value \( V \) as binomial with \( V_1 > V_2 \) and \((V_2 - V_1)/V_1 = -L\) across all firms
\[
V \sim \begin{cases} V_1 & \text{with probability } 1-p, \\ V_2 = (1-L)V_1 & \text{with probability } p. 
\end{cases}
\]

The probabilities of liquidation associated with firm value \( V_1 \) and \( V_2 \), \( q(V_1) \) and \( q(V_2) \), satisfy the following condition:
\[
(1-q(V_2)) \cdot C(V_2, T_2) < C(V_2, T_2) < C(V_1, T_2)
\]
\[
< (1-q(V_1)) \cdot C(V_1, T_1).
\]

With the above condition, Proposition 1 implies that at date 1, when firm value is \( V_1 \), managers choose not to file for Chapter 11; when firm value is \( V_2 \), managers choose to file. Hence, investors’ prior about the distribution of firm value determines their perceived Chapter 11 filing probability. The perceived Chapter 11 filing probability at date 0 is equal to the probability when firm value is low: \( V = V_2 \). With Proposition 2, we can calculate the equity value at date 0 and date 1
\[
E_0 = p \cdot C(V_2, T_2) + (1-p) \cdot [(1-q(V_1)) \cdot C(V_1, T_1)],
\]
\[
E^1 = C(V_2, T_2).
\]

The model-predicted stock return \( R \) is as follows:
\[
R = \frac{E^1 - E_0}{E_0} = \frac{C(V_2, T_2) - pC(V_2, T_2) + (1-p)(1-q(V_1))C(V_1, T_1)}{pC(V_2, T_2) + (1-p)(1-q(V_1))C(V_1, T_1)}.
\]

I further assume that \( q(V_1) = 0 \) for all firms. Considering that \( q(V_1) \) is the chance of liquidation when firm value is high, it is a reasonable assumption. Under this assumption, the model-predicted stock return \( R \) around Chapter 11 filing is given by
\[
R = \frac{C(V_2, T_2) - pC(V_2, T_2) + (1-p)LC(V_1, T_1)}{pC(V_2, T_2) + (1-p)LC(V_1, T_1)}.
\]

We can decompose the model-predicted stock return \( R \) into two parts: the change of call option value \( R^* \) and the perceived bankruptcy filing probability \( p \):
\[
R^* = \frac{C(V_2, T_2) - C(V_1, T_1)}{C(V_1, T_1)}, \quad R = \frac{(1-p)R^*}{1 + pR^*}.
\]

Intuitively, the stock return \( R \) around filing should be positively related to the change of the option value \( R^* \). The more investors have anticipated the filing, the less of an impact the announcement has on stock prices.

Specifically, the option value is reduced through two channels: the option maturity is shortened from \( T_1 \) to \( T_2 \) and firm value is reduced from \( V_1 \) to \( V_2 \) due to the signaling effect of Chapter 11 filing. We can further decompose \( R^* \) into changes in these two channels. By construction, the percentage change of firm value is \(-L\). Denote maturity change by \( K = (T_2 - T_1)/T_1 \), the elasticity of the call option value with respect to \( w.r.t. \) the change of \( T \) by \( ELAS_{VT} \), and the elasticity of the call option value \( w.r.t. \) the change of \( V \) by \( ELAS_{Vv} \). By the first-order Taylor Expansion approximation
\[
R^* = \frac{C(V_2, T_2) - C(V_1, T_1)}{C(V_1, T_1)} \approx \frac{\partial C}{\partial T} \bigg|_{T = T_1} \cdot (T_2 - T_1) + \frac{\partial C}{\partial V} \bigg|_{V = V_1} \cdot (V_2 - V_1)
\]
\[
= K \cdot ELAS_{VT} + \frac{-L}{1 + p(K \cdot ELAS_{VT} + (-L) \cdot ELAS_{Vv})}.
\]

Simple algebra shows
\[
\frac{\partial R}{\partial K} \geq 0, \quad \frac{\partial R}{\partial p} \geq 0.
\]

The representation of the model-predicted stock return \( R \) by \( K, -L, ELAS_{VT}, ELAS_{Vv} \), and \( p \) allows us to estimate the mean level of shareholder loss due to Chapter 11 filing, and conduct cross-sectional analysis to explain why some firms suffer larger losses than others.

4. Empirical testing

4.1. Regression equations

Let \( CAR_i \) denote the observed shareholder loss for firm \( i \) around filing, measured by the cumulative abnormal return of the stock. The main test of the model is to test whether the model-predicted stock return \( R_i \) computed in Eq. (6) is able to explain the observed \( CAR_i \),
\[
CAR_i = \beta_1 R_i + \beta_2 \cdot \text{control variables}_i + \epsilon_i.
\]

I expect \( \beta_1 \) in regression (13) to be significantly greater than zero. Preferably, \( \beta_1 \) should be close to one. The

\[\text{delta} = \frac{\partial C}{\partial V} = N(d_1), \quad \text{theta} = \frac{\partial^2 C}{2 \partial T^2} = \frac{\partial N(d_1) \sigma}{\sqrt{T}} + r X e^{-T} N(d_2).\]
magnitude of \( \beta_1 \) depends on how realistic model assumptions are and the valuation methods shareholders actually use. If shareholders expect the firm to continue its business activities during Chapter 11, the fundamental analysis they conduct should be captured sufficiently by the model. In some rare cases, investors might evaluate the firm in a different context, such as whether the firm is a potential acquisition candidate. There may also be noise terms from simple features of the model and measurement errors of variables. Thus, it is likely that \( \beta_1 \) is not equal to one. Since the goal is to test whether the model has some power in explaining cross-sectional CAR, the null hypothesis is \( H_0 : \beta_1 > 0 \).

The model also predicts the relationship of CAR with the change of the option value \( R^n \) and the perceived bankruptcy filing probability \( p \) as shown in Eq. (8)

\[
\text{CAR}_t = \alpha + \beta_1 R^n_t + \beta_2 p_t + \beta_3 \cdot \text{control variables}_i + \epsilon_i. \tag{14}
\]

By Eq. (8), I expect \( \beta_1 > 0 \) and \( \beta_2 > 0 \). \( \beta_3 \) indicates the sensitivity of returns to the perceived filing probability \( p \).

To directly test the effect of maturity shortening \( K \) on \( \text{CAR}_t \), I run the following regression:

\[
\text{CAR}_t = \alpha + \beta_1 K_t + \beta_2 p_t + \beta_3 \cdot \text{control variables}_i + \epsilon_i, \tag{15}
\]

where \( \beta_1 \) indicates the sensitivity of shareholder loss to the change in the option maturity. By Eq. (12), I expect \( \beta_1 > 0 \) and \( \beta_2 > 0 \).

4.2. Sample selection

I first compile a sample of Chapter 11 filings by publicly traded firms from 1998 to 2005 with bankruptcy resolution data from Bankruptcydata.com. One hindrance for studies of bankrupt equity is the lack of pricing data from Center for Research in Security Prices (CRSP) because some bankrupt stocks are delisted before actual filings. After delisting, they normally continue to trade at the OTC market Pink Sheets. Delisting information is gathered from CRSP. For non-delisted stocks, I collect daily pricing and trading data from CRSP. For delisted stocks, daily pricing and trading data from Pink Sheets is used. Quarterly and annual filings before bankruptcy are from Compustat.

I filter the sample by the following criteria: (1) the firm has available pricing information around Chapter 11 filing, so that I can construct observed shareholder loss measured by the cumulative abnormal return CAR; (2) the last quarterly 10-Q filing before bankruptcy is within six months prior to the Chapter 11 filing date; (3) the last 10-K filing before Chapter 11 contains complete information about the debt structure of the firm, which is necessary to construct the average debt maturity \( T_1 \) before filing. Unfortunately, for around half of the original bankrupt sample, these data are missing. After these filtering criteria, the final sample contains 217 firms with non-missing values for all variables.

Among these 217 firms, there are several cases that warrant special treatment. For nine sample firms, the filing news is accompanied by other news such as DIP financing or earnings announcement. This other news may have additional effects on stock prices around the filing window. There are also ten prepackaged filings. Prepackaged Chapter 11 filings are similar to private debt workouts as the filing includes a reorganization plan. Chatterjee, Dhillon, and Ramirez (1996) show that the stock market reacts more favorably to these filings compared to regular Chapter 11 filings. Another five cases are filed by utility firms, which have the first two digits of industry SIC code of 49. Chapter 11 filings for these firms are often related to regulation issues, and not necessarily due to underlying economic distress. To take into account these three groups, three dummy variables are created corresponding to the three groups: other news, prepack, and utilities.

4.3. Variable construction

To conduct analysis in regression Eqs. (13), (14), and (15), I need to measure properly shareholder loss around filing CAR, firm value \( V_1 \) and \( V_2 \), the strike price \( X \), asset volatility \( \sigma \), investors’ perceived filing probability \( p \), the average debt maturity \( T_1 \), and the expected Chapter 11 duration \( T_2 \). The following is a detailed description of how these variables are constructed.

Shareholder loss CAR is computed using daily stock returns within the \((-1,1)\) three-day event window: \( \text{CAR}_{t-1,1} = \frac{1}{3} \sum_{i=-1}^{1} r^i_t \), where \( r_t \) is the daily stock return and \( R_{mt} \) is the equally weighted daily return of all NYSE/Amyx/Nasdaq stocks. I choose the event window of three days around filing because Clark and Weinstein (1983) show that most of the shareholder loss in longer periods is concentrated in the three-day window.

Firm value \( V_1 \) before filing is measured by the value of total assets from the last quarterly filing. The updated firm value \( V_2 \) after filing is \((1-L)V_1\) by construction. Although the model does not include bankruptcy costs, it can be easily extended to do so and model implications do not change. In fact, we can think of \( L \) having a lower bound that is equal to the bankruptcy cost as a percentage of pre-filing asset value. As reviewed in Section 2, the sample size-weighted average of the percentage bankruptcy cost across seven recent studies is 6.5%. Thus, \( -L \) is less than \(-6.5\%\) and I assume \( L = 10\%\). In robustness checks, I change \( L \) in the cross-section based on factors determining the percentage bankruptcy cost.

Strike price \( X \) is the face value of total liabilities from the last quarterly filing. It should be a reasonable measure given that firms are supposed to pay off all liabilities before shareholders get paid.

Asset volatility \( \sigma \) is computed using an approach of “comparable firms”. First, I choose not to use any volatility measures of the bankrupt firm itself, since deep

4 Mabey and Malone (2001) provide case studies of Chapter 11 filings by utility companies. In their paper, the chairman of Pacific Gas and Electric (PG&E) is quoted as follows regarding the reason for filing, “We chose to file for Chapter 11 reorganization affirmatively because we expect the court will provide the venue needed to reach a solution, which thus far the State and the State’s regulators have been unable to achieve...The regulatory and political processes have failed us, and now we are turning to the court.”

5 Using the value-weighted index does not change the results.
distress distorts their investment decisions and business activities. The average asset volatility of comparable firms is used instead for each bankrupt firm. I select all the firms that have the same first three digits of the industry SIC code as the bankrupt firm at the time of filing, and sort them into deciles by book asset value. The matching firms are the ones in the same asset size decile in the same industry. The asset volatility is constructed using the KMV-Merton model as described in Bharath and Shumway (2008).\(^6\) I calculate an annualized value of asset volatility for each matching firm in the month of Chapter 11 filing. Lastly, the average of all matching firms’ asset volatility is used as the proxy for the asset volatility \(\sigma\) of the bankrupt firm.

**Investors’ perceived bankruptcy filing probability** \(p\) captures the magnitude of surprise in the Chapter 11 filing news. The measure is based on the pre-filing accounting information and market data, which is derived from the literature of bankruptcy prediction as reviewed in Section 2. In particular, I rely on Shumway (2001) to construct the perceived filing probability.\(^7\) His paper shows that its hazard model outperforms alternative models in out-of-sample forecasts.

**Average debt maturity** \(T_1\) is the option maturity when the firm is not expected to file for Chapter 11. These data are from the last annual filing before bankruptcy. I gather the information about the face value of debt that is due in one year up to five years. When the sum of all debt value due in two to five years is less than the value of total long-term debt, I assume the difference has a maturity of six years. The average debt maturity is calculated as a face-value-weighted average of maturity for all debt.

**Investors’ expected Chapter 11 duration** \(T_2\) is the new option maturity right after Chapter 11 filing. Since the exact time duration shareholders will have to recover any value is not known at the time of filing, \(T_2\) needs to be estimated as an expected value. Normally the management remains in control after filing and has 120 days of exclusivity to submit a reorganization plan, and another 60 days to solicit approval for the plan. After the expiration of the 180-day period, any interested party including creditors can submit a reorganization plan. Although sometimes the court extends the exclusivity period, reorganization plans submitted later or by creditors are less lenient to shareholders. The 180-day period can be viewed as a period when shareholders can extract any value if the option pays off. Hence, I assume \(T_2 = 180\) days in the main empirical testing. In robustness checks, I also use the realized Chapter 11 duration as the expected duration assuming that durations can be predicted to some degree.

**Control variables** that could affect price reactions of Chapter 11 filing are constructed as follows. The pre-bankruptcy performance \(ROA\) is calculated as the ratio of net income divided by total assets. \(Size\) measured by the log of book asset value is used as another control variable. Some papers (see Atiase, 1987) argue that larger firms have more media coverage around filing than smaller firms, thus larger firms should have larger price declines. On the other hand, larger firms tend to have better quality and more pre-filing disclosures of financial difficulties, which might make filing news well-anticipated. The sign on size is thus uncertain. Bharath, Panchapagesan, and Werner (2010) find that the US bankruptcy law has become more creditor-friendly, which manifests as a shorter Chapter 11 duration and less frequent APR violations after 2000. This means Chapter 11 filing has become more adverse for shareholders. To control for this effect, I include a dummy variable \(Dummy (Year \geq 2001)\) that equals one if filing occurs in 2001 or later, and zero otherwise. I expect the sign on this dummy variable to be negative. Lastly, around one-third of sample firms are delisted before bankruptcy filing and traded on Pink Sheets. I construct a dummy variable that equals one if the firm is delisted before the event window, and zero otherwise. This can potentially capture two effects of delisting: firms that are delisted before filing should have worse quality than others; it can also capture an “exchange” effect in the sense that stocks traded on Pink Sheets might react differently to the filing news from the ones listed on main exchanges. Filings that are accompanied by other news such as DIP financing, prepackaged, or filed by firms in the utilities industry should have better stock price reaction compared to others. I create dummy variables other news, prepack, and utilities for these three cases, respectively.

### 4.4. Data description

Table 1 describes exchange venues where stocks are traded on the Chapter 11 filing announcement day and bankruptcy resolution outcomes. Panel A shows numbers of filings grouped by exchanges while Panel B shows numbers of filings grouped by bankruptcy outcomes in each year from 1998 to 2005. The number of filings in the sample does not vary much over the years except from 2001 to 2003, when the numbers are almost doubled compared to other years. This could be related to the burst of the “dot com” bubble. Around half of the sample firms are traded on Nasdaq and one-third are delisted before filing. Regarding outcomes, about 47% of the sample firms are successfully reorganized, 32% are liquidated, 12% are acquired, and 6% are dismissed. The distribution is consistent with the literature and shows that the sample is representative to study.
Table 2 describes firm characteristics and regression variables. Panel A reports their distribution summary statistics. The mean total asset value of the sample is $1046 million (mm) with a standard deviation of $3463 mm. The sample is not concentrated in only small or large firms. Leverage is calculated as the ratio of total liabilities to total assets, and most sample firms are highly levered with a mean value of 1.53 and a standard deviation of 5.22. Sample firms on average are economically distressed with a mean pre-filing ROA of 25%. The sample demonstrates diverse business risk in the cross-section: annualized asset volatility has a mean of 0.72 and a standard deviation of 0.4. The minimum average debt maturity $T_{i}$ is one year and the mean is 2.34 years. Investors' perceived Chapter 11 filing probability $p$ has a mean of 0.28 and a standard deviation of 0.32. It is approximately evenly distributed on (0, 1). Panel B shows the correlation matrix of variables. Pearson correlations are shown below the diagonal with Spearman correlations above the diagonal. Larger firms tend to have higher ROA and lower asset volatility. Meanwhile, average debt maturity has low correlations with major firm characteristics.

5. Empirical results

5.1. Distribution comparison of observed CAR and the model-predicted stock return $R$

In this section I conduct empirical tests of the model described in Section 4. The model predicts that shareholder loss around filing $CAR_{-1,1}$ is determined simultaneously by the change of the option value due to option maturity shortening $K$, new adverse information of firm value $L$, and investors' perceived bankruptcy filing probability $p$.

As a first step of testing the model, I compare the magnitude of shareholder loss due to maturity shortening and revealed adverse information about firm value with the observed $CAR_{-1,1}$. Table 3 shows the distribution of the observed stock return $CAR_{-1,1}$ and the model-predicted stock return $R$. The average $CAR_{-1,1}$ is 37% with a standard deviation of 28%. The predicted return $R$ computed as in Eq. (6) has a mean value of 54% and a standard deviation of 29%. Overall, the model-predicted shareholder loss has a similar magnitude to the observed $CAR_{-1,1}$.

The change of the option value $R$ has a mean of 63%. By construction, it is larger in magnitude than $R$ as shown in Eq. (7). Lastly, I decompose $R$ into two partial changes induced by shortened option maturity and reduced firm value. In the sample, the average maturity shortening $K$ is 70%, the average elasticity to the maturity change is 0.68, and the product of these two transforms to an average partial change of the option value of 45%. Average firm value change is 10% by assumption, the average elasticity to the firm value change is 2.43, and the product of these two generates an average partial change of the option value of 24%. This shows that option maturity shortening accounts for a large proportion of shareholder loss around filing.

To investigate how sensitive the predicted stock return $R$ is to the assumption that the change of firm value is 10% around filing, Table 4 provides the distribution...
comparison when the change of firm value $-L$ takes the values of $-5\%$, $-10\%$, $-15\%$, and $-20\%$, respectively. While the predicted return $R$ becomes more negative when the magnitude of firm value change is larger, its distribution is similar to the observed CAR for all four values of $-L$. Since the average percentage bankruptcy cost according to the literature is $6.5\%$, which is a lower bound for the reduced firm value, I continue to use $L = -10\%$ in the main testing.

5.2. Regression results of a base model

I test whether the model described in Section 3.2 successfully explains the cross-sectional variation in observed shareholder loss CAR with regression Eqs. (13)–(15). The results are presented in Table 5. Model 1 shows regression results when the model-predicted stock return $R$ is the only explanatory variable. Consistent with the hypothesis, the coefficient on $R$ is significantly positive. The predicted return $R$ alone is able to explain 3.8% of the cross-sectional variation in observed CAR.

8 To make sure the results are not driven by extreme values, I also winsorize total liabilities, total assets, average debt maturity, and perceived filing probability at the 1% level as a robustness check. The results remain the same. The table is not included in the paper, but available from the author upon request.
Table 4

Observed CAR and model-predicted stock returns with alternative values of the change in firm value \(-L\).

This table presents the distribution comparison of observed CAR and model-predicted stock returns with alternative values of the change in firm value around Chapter 11 filing. The model-predicted stock return \(R\) is calculated with the change in firm value \(-L\) equal to \(-5\%, -10\%, -15\%, \) and \(-20\%, \) respectively.

<table>
<thead>
<tr>
<th>Firm value change (-L = (V_2 - V_1)/V_1)</th>
<th>N</th>
<th>MIN</th>
<th>Q1</th>
<th>MEDIAN</th>
<th>Q3</th>
<th>MAX</th>
<th>MEAN</th>
<th>StdDev</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observed CAR (-1, 1)</td>
<td>217</td>
<td>-92%</td>
<td>-62%</td>
<td>-37%</td>
<td>-13%</td>
<td>29%</td>
<td>-37%</td>
<td>28%</td>
</tr>
<tr>
<td>Predicted stock return (R)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(-5%)</td>
<td>217</td>
<td>100%</td>
<td>-73%</td>
<td>-47%</td>
<td>-23%</td>
<td>0%</td>
<td>-49%</td>
<td>30%</td>
</tr>
<tr>
<td>(-10%)</td>
<td>217</td>
<td>100%</td>
<td>-78%</td>
<td>-54%</td>
<td>-32%</td>
<td>0%</td>
<td>-54%</td>
<td>29%</td>
</tr>
<tr>
<td>(-15%)</td>
<td>217</td>
<td>100%</td>
<td>-82%</td>
<td>-64%</td>
<td>-41%</td>
<td>0%</td>
<td>-60%</td>
<td>29%</td>
</tr>
<tr>
<td>(-20%)</td>
<td>217</td>
<td>100%</td>
<td>-88%</td>
<td>-72%</td>
<td>-51%</td>
<td>0%</td>
<td>-66%</td>
<td>28%</td>
</tr>
</tbody>
</table>

Table 5

Explaining the observed stock return with the model-predicted stock return.

This table presents coefficient estimates and \(t\)-statistics of OLS regression of \(\text{CAR}_{-1, 1}\) on the model-predicted stock return \(R\) and control variables. Model 1 uses the model-predicted stock return \(R\) as the only explanatory variable; Model 2 uses \(R\) and control variables as in Eq. (13); Model 3 uses the model-predicted option value change \(R^*\), the perceived filing probability \(p\), and control variables as in Eq. (14); Model 4 uses the maturity change \(K\), the perceived filing probability \(p\), and control variables as in Eq. (15). \(R\) is computed as in Eq. (6); \(R^*\) is computed as in Eq. (7); \(K\) is (0.5 – average debt maturity)/average debt maturity; year \(\geq 2001\) equals one if the firm files for Chapter 11 in 2001 or later, and zero otherwise; ROA is the ratio of net income divided by total assets; size is the log of total assets; delisted is one if the firm is delisted before the event window, and zero otherwise. The dummy variables other news, prepack, and utilities are equal to one when filings are accompanied by other news such as DIP financing, prepackaged, or filed by firms in the utilities industry, respectively. White (1980) heteroskedasticity-robust standard errors are used to calculate the \(t\)-statistics, shown in parentheses. ** and * represent significance at the 5% and 10% levels.

<table>
<thead>
<tr>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predicted stock return (R)</td>
<td>0.198** (3.01)</td>
<td>0.226** (3.45)</td>
<td>0.180* (1.96)</td>
</tr>
<tr>
<td>Option value change (R^*)</td>
<td></td>
<td>0.123** (1.93)</td>
<td>0.182** (2.99)</td>
</tr>
<tr>
<td>Option maturity change (K)</td>
<td></td>
<td></td>
<td>0.218* (1.80)</td>
</tr>
<tr>
<td>Perceived filing probability (p)</td>
<td>-0.105** (-2.78)</td>
<td>-0.104** (-2.71)</td>
<td>-0.103** (-2.77)</td>
</tr>
<tr>
<td>Year (\geq 2001)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ROA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delisted</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other news</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prepack</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Utilities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adj. (R)</td>
<td>3.8%</td>
<td>17.7%</td>
<td>17.6%</td>
</tr>
<tr>
<td>(N)</td>
<td>217</td>
<td>217</td>
<td>217</td>
</tr>
</tbody>
</table>

In Model 2 I add control variables in the regression as in Eq. (13). After controlling for these variables, the predicted return \(R\) remains highly significant. I find that Chapter 11 filings are more negative corporate events for shareholders after 2001, which are related to more negative observed CARs. This is consistent with Bharath, Panchapagesan, and Werner (2010), which states that the bankruptcy law in the US has become more creditor-friendly over time. ROA does not affect stock returns around filing time. The coefficient on delisted is insignificant, suggesting the stock market does not differentiate the listing venue of the stock when Chapter 11 is filed. Consistent with my conjecture, filings that are accompanied by other news, prepackaged, or filed by utilities firms have better stock price reaction compared to other filings.

In Model 3 the predicted stock return \(R\) is decomposed into the option value change \(R^*\) and investors’ perceived bankruptcy filing probability \(p\) as in Eq. (14). Consistent with the model prediction, the coefficients on \(R^*\) and \(p\) are both significantly positive. The more the option value changes due to maturity shortening and underlying firm value reduction, the more stock price drops around the filing news; the more investors anticipate the filing, the less stock price declines. These two effects are present while controlling for other firm characteristics.

In Model 4 I further decompose the predicted stock return \(R\) into the change of option maturity \(K\) and the perceived filing probability \(p\) as in Eq. (15). As predicted by the model, the coefficients on \(K\) and \(p\) are both significantly
positive. The more the option maturity shortens, the more stock price declines around the filing news.

5.3. Cross-sectional variation in firm value change

In Table 5, I keep the firm value change around filing \(-L\) constant across all firms, which is equal to \(-10\%\). As argued before, the change of firm value should be related to direct bankruptcy costs. Bankruptcy costs can be viewed as a lower bound for the amount of firm value reduction due to filing. Several papers find that some factors are related to the magnitude of bankruptcy costs as a percentage of pre-filing firm asset value in the cross-section of bankrupt firms. The common factors include tangibility of assets, solvency, size, and industry. Betker (1997), among others, shows that the percentage bankruptcy cost decreases with size and solvency measured by pre-filing leverage ratio. Thorburn (2000) confirms that the percentage cost decreases with firm size, and additionally it decreases with asset tangibility. She also finds that when the bankrupt firm belongs to a more distressed industry (measured by the percentage of firms with interest coverage ratio less than one), the percentage cost is higher. A recent paper by Bris, Welch, and Zhu (2006) also shows that the percentage cost is related to solvency of the firm. Due to data limitations, I cannot estimate the percentage bankruptcy cost for sample firms directly. These papers study different samples in different time periods. I assume that all these bankrupt samples including mine are randomly drawn, hence regression estimates reflect true population parameters. Among these studies, the sample sizes of Thorburn (2000) (213 observations) and Bris, Welch, and Zhu (2006) (194 observations) are the closest to mine (217 observations), I thus use their regression estimates to estimate the percentage bankruptcy cost for sample firms.

In Thorburn (2000), she divides the whole sample into three groups by asset size, finding that the coefficient on “large” firms is \(-0.061\) and the coefficient on “medium” firms is \(-0.037\). Furthermore, the coefficient on asset tangibility is \(-0.003\), and the coefficient on the industry distress level is 0.059. Bris, Welch, and Zhu (2006) show that the coefficient on the dummy variable when the debt to asset ratio is higher than one, which is defined as insolvency, is 0.004. I construct the same variables and estimate the percentage bankruptcy cost for sample firms with the following formula:

\[
\text{percentage bankruptcy cost} = 0.1 - 0.061 \times \text{large} - 0.037 \times \text{medium} - 0.003 \times \text{tangibility} \\
+ 0.059 \times \text{industry distress} + 0.004 \times \text{insolvency},
\]

where large is a dummy variable that is one if the firm belongs to the top one-third in the sample ranked by firm size and zero otherwise, medium is a dummy variable that is one if the firm belongs to the middle one-third in the sample ranked by firm size and zero otherwise, tangibility is the ratio of tangible assets over total assets, industry distress is the percentage of firms with interest coverage ratio less than one in the same industry (defined by the same three-digit SIC code) of the bankrupt firm, insolvency is a dummy variable that is one if the bankrupt firm has a debt to asset ratio higher than one and zero otherwise. Calculated this way, the percentage bankruptcy cost for sample firms has a mean of 10.3%, a min of 5.9%, and a max of 15.7%, which is a reasonable distribution given the findings in the bankruptcy cost literature.

I then incorporate the cross-sectional variation of percentage bankruptcy costs into the model testing. Instead of having the change of firm value around filing \(-L = -10\%\) for all firms, I set it to be equal to the estimated percentage bankruptcy cost, while everything else remains the same. The regression results for Eqs. (13) and (14) are reported in Table 6. The coefficients on the predicted return \(R\) and the change of the option value \(R^*\) remain significantly positive. Comparing the estimation results with those in Table 5, which assumes \(L = 10\%\) for all sample firms, I find that both coefficient estimates of these variables and R-squared are higher. Incorporating the cross-sectional variation in the percentage bankruptcy cost into the model significantly improves the power of the predicted stock return \(R\) in explaining the observed \(\text{CAR}\).

5.4. An alternative measure for expected Chapter 11 duration \(T_2\)

In the base model testing in Section 5.2, I assume that \(T_2 = 180\) days = 0.5 years for all sample firms, since the realized duration is not known at the time of filing. The 180-day period is the exclusivity period, when only the debtor has the right to submit a reorganization plan. However, it is also possible that the expected option maturity post-filing is related to the ex post observed Chapter 11 duration. As a robustness check, I use the realized Chapter 11 duration as an alternative measure for the option maturity after filing. Denote the realized Chapter 11 duration as \(D\). Note that \(D\) is an upper bound for the real option maturity \(T_2\), because shareholders have less time to extract any value compared to the whole reorganization duration with a final plan approved. To remove the effect of extreme values, I use the trimmed distribution of \(D\) for the option maturity \(T_2^\prime = T_2\) = 30 days, if \(D < 30\) days; \(T_2 = D\), if \(30\) days \(< D < 365\) days; \(T_2 = 365\) days, if \(D \geq 365\) days. I then run the same regressions as in Eqs. (13) and (14). The results are presented in Table 7. The coefficients on the predicted return \(R\) and the option value change \(R^*\) remain significantly positive. I conclude that the results are robust under this alternative measure of \(T_2\). However, the fit of the regression is significantly lower when using the actual realized duration as the expected option maturity after filing. This suggests that the expected option maturity after filing is
not closely related to the actual duration. Rather, the 180-
day exclusivity period is a more accurate proxy for the ex-
pected option maturity after filing.

6. Discussion of results

6.1. The change of firm business risk around Chapter 11 filing

The model in Section 3.2 assumes that firm asset vol-
tility $\sigma$ remains the same around Chapter 11 filing. 
However, this might not be the case in reality. On one hand, 
business risk could be lower after filing due to legal 
constraints on bankrupt firms. For example, in some 
Chapter 11 cases managers need to get bankruptcy 
judges’ approval before taking on new production or 
investment projects. They are usually required to sign a 
claim that these new projects will not increase current 
business risk. The option value is thus further reduced by 
Chapter 11 filing due to the reduction of the option’s 
underlying asset volatility.

Table 6
Explaining the observed stock return with the model-predicted stock return incorporating the cross-sectional variation in the change of firm value.

This table presents coefficient estimates and $t$-statistics of OLS regression of $\text{CAR}_{t-1}$ on the model-predicted stock returns $R$ and control variables. Model 1 uses the model-predicted stock return $R$ as the only explanatory variable; Model 2 uses the predicted return $R$ and control variables as in Eq. (13); Model 3 uses the model-predicted option value change $R^n$, the perceived filing probability $p$, and control variables as in Eq. (14); $R$ is computed as in Eq. (6); $R^n$ is computed as in Eq. (7); year $\geq 2001$ equals one if the firm files for Chapter 11 in 2001 or later, and zero otherwise; ROA is the ratio of net income divided by total assets; size is the log of total assets; delisted is one if the firm is delisted before the event window, and zero otherwise. The dummy variables other news, prepack, and utilities are equal to one when filings are accompanied by other news such as DIP financing, prepackaged, or filed by firms in the utilities industry, respectively. White (1980) hetero-
skedasticity-robust standard errors are used to calculate the $t$-statistics, shown in parentheses. ** and * represent significance at the 5% and 10% levels.

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predicted stock return $R$</td>
<td>0.217** (3.31)</td>
<td>0.229** (3.52)</td>
<td>0.195** (2.11)</td>
</tr>
<tr>
<td>Option value change $R^n$</td>
<td>0.115* (1.78)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived filing probability $p$</td>
<td></td>
<td></td>
<td>0.011 (0.03)</td>
</tr>
<tr>
<td>Year $\geq 2001$</td>
<td>$-0.104^{**}$ $(-2.78)$</td>
<td>$-0.104^{**}$ $(-2.73)$</td>
<td></td>
</tr>
<tr>
<td>ROA</td>
<td>$-0.005$ $(-0.74)$</td>
<td>$-0.004$ $(-0.91)$</td>
<td></td>
</tr>
<tr>
<td>Size</td>
<td>0.015 (1.46)</td>
<td>0.014 (1.19)</td>
<td></td>
</tr>
<tr>
<td>Delisted</td>
<td>0.003 (0.07)</td>
<td>0.004 (0.11)</td>
<td></td>
</tr>
<tr>
<td>Other news</td>
<td>0.244** (2.16)</td>
<td>0.237** (2.12)</td>
<td></td>
</tr>
<tr>
<td>Prepack</td>
<td>0.339** (3.91)</td>
<td>0.340** (3.89)</td>
<td></td>
</tr>
<tr>
<td>Utilities</td>
<td>0.131 (1.58)</td>
<td>0.140* (1.66)</td>
<td></td>
</tr>
<tr>
<td>Adj. $R$</td>
<td>5.0% 18.0% 18.0%</td>
<td>217 217 217</td>
<td></td>
</tr>
</tbody>
</table>

Table 7
Explaining the observed stock return with the model-predicted stock return using realized Chapter 11 durations.

This table presents coefficient estimates and $t$-statistics of OLS regression of $\text{CAR}_{t-1}$ on the model-predicted stock returns $R$ and control variables. Model 1 uses the model-predicted stock return $R$ as the only explanatory variable; Model 2 uses the predicted return $R$ and control variables as in Eq. (13); Model 3 uses the model-predicted option value change $R^n$, the perceived filing probability $p$, and control variables as in Eq. (14); $R$ is computed as in Eq. (6); $R^n$ is computed as in Eq. (7); year $\geq 2001$ equals one if the firm files for Chapter 11 in 2001 or later, and zero otherwise; ROA is the ratio of net income divided by total assets; size is the log of total assets; delisted is one if the firm is delisted before the event window, and zero otherwise. The dummy variables other news, prepack, and utilities are equal to one when filings are accompanied by other news such as DIP financing, prepackaged, or filed by firms in the utilities industry, respectively. White (1980) hetero-
skedasticity-robust standard errors are used to calculate the $t$-statistics, shown in parentheses. ** and * represent significance at the 5% and 10% levels.

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predicted stock return $R$</td>
<td>0.116* (1.86)</td>
<td>0.175** (3.03)</td>
<td>0.120* (1.65)</td>
</tr>
<tr>
<td>Option value change $R^n$</td>
<td></td>
<td></td>
<td>0.146* (2.26)</td>
</tr>
<tr>
<td>Perceived filing probability $p$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year $\geq 2001$</td>
<td>$-0.103^{**}$ $(-2.69)$</td>
<td>$-0.100^{**}$ $(-2.59)$</td>
<td></td>
</tr>
<tr>
<td>ROA</td>
<td>$-0.003$ $(-0.27)$</td>
<td>$-0.002$ $(-0.27)$</td>
<td></td>
</tr>
<tr>
<td>Size</td>
<td>0.018* (1.67)</td>
<td>0.013 (1.07)</td>
<td></td>
</tr>
<tr>
<td>Delisted</td>
<td>$-0.011$ $(-0.28)$</td>
<td>0.001 (0.03)</td>
<td></td>
</tr>
<tr>
<td>Other news</td>
<td>0.262** (2.34)</td>
<td>0.244** (2.22)</td>
<td></td>
</tr>
<tr>
<td>Prepack</td>
<td>0.356** (3.98)</td>
<td>0.353** (3.95)</td>
<td></td>
</tr>
<tr>
<td>Utilities</td>
<td>0.163* (1.93)</td>
<td>0.158* (1.79)</td>
<td></td>
</tr>
<tr>
<td>Adj. $R$</td>
<td>1.2% 16.3% 17.1%</td>
<td>217 217 217</td>
<td></td>
</tr>
</tbody>
</table>

On the other hand, firm asset volatility could also increase since Chapter 11 filing can bring more uncer-
tainty to the operation and business of the firm. For example, firms might need to sell some assets, and 
managers could be replaced. Li and Zhong (2011) show 
that stocks in Chapter 11 exhibit higher daily volatilities 
than at the pre-filing level. Although high stock volatility 
could result from the leverage effect of lower equity value 
or information uncertainty about the true value of these 
stocks, it also indicates a possibility of higher asset 
volatility after Chapter 11 filing.

Since it is hard to quantify the change in option 
volatility, I do not consider this effect in the analysis. 
Future research could be conducted in this area when 
better understanding and data availability are achieved. 
Again, the purpose of this paper is not to prove that 
Chapter 11 filing has solely two effects: revealing new 
adverse information about firm value and shortening 
option maturity, but to point out that these two play a 
crucial role in determining shareholder loss around filing 
besides other possible effects.
6.2. Policy implications on the Chapter 11 process

Finance professionals and academics have considered the US bankruptcy law to be more debtor-friendly than in other countries. One reason is the prolonged stay in Chapter 11 for US bankrupt firms. It is pointed out that this is inefficient in terms of generating higher bankruptcy costs with larger professional fees paid to lawyers and auditors. This paper suggests that the prolonged Chapter 11 duration is inefficient from another perspective. Because distressed equity has an embedded option value, an expected prolonged Chapter 11 duration will increase the chance of moral hazard in excessive risk taking by shareholders ex ante. Thus, the prolonged Chapter 11 duration not only induces inefficiency ex post for bankrupt firms, but also ex ante for all firms. This is consistent with the empirical evidence that when managers hold a larger amount of shares, they tend to delay the filing of a reorganization plan during Chapter 11 (see Betker, 1995). Meanwhile, the very goal of Chapter 11 is to provide rehabilitation for distressed firms. As value-increasing activities take time, shorter Chapter 11 durations are not necessarily better. I conjecture that there is a limited time for the exclusivity period: a Chapter 11 debtor’s exclusive period to file a reorganization plan will be limited under the Act to a period of 18 months from the date the debtor files a Chapter 11 petition.10 This change could be viewed as a response to the criticism about the prolonged Chapter 11 duration. As an alternative, I propose that the court consider different Chapter 11 durations for different firms based on specific firm characteristics.

7. Conclusion

This paper provides an endogenous Chapter 11 filing model in an option framework to study shareholder loss caused by Chapter 11 filing. First, it formally models how new adverse information about the firm value is incorporated into share prices, which is the first in the literature to my knowledge. I show that Chapter 11 filing reveals new information to the market through a “signaling” effect: only low-value firms choose to file for Chapter 11 voluntarily and high-value firms choose not to file. Second, I model another important channel for shareholder loss induced by filing, which is a nonlinear wealth transfer from shareholders to creditors through accelerated payments to creditors. This channel accounts for a large proportion of the shareholder loss around filing. Lastly, I use the model to quantify the amount of shareholder loss around filing. It is simultaneously determined by maturity shortening of the option shareholders have on firm assets, new adverse information about the underlying firm value, and investors’ perceived filing probability. The model-predicted shareholder loss has comparable magnitude as observed stock returns around filing and is able to explain the cross-sectional variation of the latter.

Appendix A

A.1. Proof of Proposition 1

1. When \( T_1 > T_2 \), define \( f(V) = (1-q(V)) \cdot C(V,T_1) - C(V,T_2) \). It is obvious that \( f(0) = 0 \).

In order to show there exists a threshold level \( V^* > 0 \) such that:

- \( f(V^*) = 0 \) for all \( V > V^* \).
- \( f(V) > 0 \) for all \( V < V^* \).
- \( f(V) < 0 \).

we need to show \( f(\cdot) \) is strictly convex for \( V > 0 \) and there exists \( V^* > 0 \) such that \( f(V^*) = 0 \).

Denote \( \frac{\partial^2 C(V,T_1)}{\partial V^2} = \gamma(V,T) \) and \( \frac{\partial^2 C(V,T_1)}{\partial V^2} = \gamma(V,T) \).

Denote \( \frac{\partial^2 C(V,T_1) / \partial V^2}{\partial^2 C(V,T_1) / \partial V^2} = \gamma(V,T) \).

\[
\frac{\partial^2 f(V)}{\partial V^2} = (1-q(V))\gamma(V,T)
\]

\[
-2q(V)\delta(V,T_1) - q^2(V)C(V,T_1) - \delta(V,T_2) > 0,
\]

\[
V^* = q^{-1} \left( 1 - \frac{C(V,T_2)}{C(V,T_1)} \right).
\]

2. When \( T_1 \leq T_2 \), we have \( (1-q(V))C(V,T_1) \leq C(V,T_1) \leq C(V,T_2) \).

A.2. Proof of Proposition 2

1. Given \( T_1 > T_2 \), by the result of Proposition 1, firms file for Chapter 11 if and only if \( V < V^* \). At date 0, since investors’ prior about the distribution of firm value \( V \) follows a uniform distribution \( V \sim U(a,b) \):

Perceived probability of filing \( P(V < V^*) = \frac{V^*-a}{b-a} \).

2. At date 0, equity value \( E^0 \) is determined by investors’ prediction whether the firm will file for Chapter 11 at date 1:

\[
E^0 = \int_a^{V^*} \frac{1}{b-a} \left[ E^0_1(V) \cdot 1(V > V^*) + E^0_2(V) \cdot 1(V < V^*) \right] dV
\]

\[
= \int_{V^*}^{b} \frac{1}{b-a} E^0_1(V) dV + \int_{V^*}^{V^*} \frac{1}{b-a} E^0_2(V) dV
\]

\[
= \int_{V^*}^{b} \frac{1}{b-a} [1-q(V)] \cdot C(V,T_1) dV + \int_{1}^{V^*} \frac{1}{b-a} C(V,T_2) dV.
\]

At date 1, after observing the firms file for Chapter 11, investors update the distribution of \( V \) to be \( V \sim U(a,V^*) \). Equity value \( E^1 \) after Chapter 11 filing is

\[
E^1 = \int_{V^*}^{V^*} \frac{1}{b-a} C(V,T_2) dV.
\]

From \( E^1 < E^0 \), the stock return \( R = (E^1 - E^0)/E^0 < 0 \).

10 The exclusivity period could be extended numerous times under the previous law, and in many larger cases has been extended for years.
References


