Received 2 January 2019
Revised 21 June 2019
Accepted 8 July 2019

The information content of stock prices after bankruptcy

Does volatility affect the probability of successful emergence?

Hirofumi Nishi
Department of Economics, Finance and Accounting, Fort Hays State University, Hays, Kansas, USA, and
S. Drew Peabody
Department of Finance and Managerial Economics, The University of Texas at Dallas, Richardson, Texas, USA

Abstract

Purpose – The purpose of this paper is to investigate if the volatility of stock prices in the days surrounding the Chapter 11 bankruptcy process predicts a firm's likelihood to successfully restructure and emerge from bankruptcy.

Design/methodology/approach – The authors use a sample of Chapter 11 cases between 1980 and 2016 that have available stock price data surrounding the bankruptcy filing dates. Following Goyal and Wang (2013), the KMV–Merton model is utilized to estimate the probability that a firm successfully emerges from its restructuring process. In order to interpret the market's assessment about a firm, the authors use the analogy of a European call option to derive the assessment of the firm's prospects as the probability that it will emerge from bankruptcy. This estimated probability of emergence is compared to actual outcomes of bankruptcy cases and tested for significance using various regression techniques.

Findings – This study exploits the information found in stock prices surrounding the bankruptcy process and finds that volatility after, but not before, filing for bankruptcy significantly predicts a firm's likelihood to emerge. In addition, the market-based probability of emergence has better predictive power on the recovery rates of unsecured creditors than measures based on financial statements.

Originality/value – Predictors of bankruptcy have been extensively studied by scholars over the decades, with early studies focusing on accounting-based measures and recent studies incorporating market-driven variables. However, in recent years, studies have begun to assess bankrupt firms' ability to reorganize and successfully emerge from bankruptcy. This study contributes to the recent literature investigating market-based predictors of successful emergence.

Keywords Bankruptcy, Emergence, Market efficiency, Real option

Paper type Research paper

1. Introduction

1.1 Background information

Corporate bankruptcy has been researched by scholars and practitioners since the 1960s following the seminal works of Modigliani and Miller (1958, 1963) that established the capital structure irrelevancy theory. A key assumption of this theory is that firms operate in frictionless markets with no bankruptcy costs in order to establish that the value of the firm is not dependent on financing decisions. However, in the decades since this initial work, scholars continued to re-examine this assumption and concluded that the total costs of bankruptcy can be more than 15 percent of firm value, comprising of direct costs of 1–6 percent (Warner, 1977; LoPucki and Kalin, 2001) and indirect costs of 11–17 percent depending on the industry (Altman, 1984)[1]. Since bankruptcy costs are significant, fully understanding what causes firms to file for bankruptcy as well as the factors that influence the successful emergence from

JEL Classification — G14, G33

Managerial Finance
Vol. 45 No. 9, 2019
pp. 1166-1182

0307-4358
DOI 10.1108/MF-01-2019-0005

bankruptcy is of great importance. Research of corporate bankruptcy has changed over time as early studies of corporate bankruptcy primarily focus on the predictors of bankruptcy (e.g. Altman, 1968; Ohlson, 1980; Lennox, 1999; Hillegeist *et al.*, 2004; among others). Later studies, especially during the past several years, begin to evaluate the factors and conditions that best influence firms' ability to successfully emerge from bankruptcy (e.g. Altman, 2014; Bryan *et al.*, 2014; LoPucki and Doherty, 2015; Ivashina *et al.*, 2016; among others). Successful reorganization during this expensive and disruptive process is relevant to all firm stakeholders.

When a firm goes bankrupt, its stock is typically delisted from major exchanges and transferred to the OTC market or regional exchanges. When a firm emerges from bankruptcy, an entirely new issue of common stock could be initiated. This makes it difficult for researchers to conduct long-term analyses, and stock performance of bankrupt firms during the Chapter 11 process has not been examined extensively in the literature. Among the few works on post-bankruptcy stock performance are Dichev (1998) investigating whether bankruptcy risk is priced in subsequent security returns and Eberhart *et al.* (1999) documenting strong positive long-term excess returns of emerging firms due to better earnings results. More recently, Dawkins *et al.* (2007) report that negative abnormal returns during the filing period tends to be associated with favorable returns during the post-filing period. The primary interest of these studies is to examine bankrupt firms' excess returns in the pre-filing through post-emerging periods. While the motivation of this research is certainly of relevance to investors, our goal in this paper is to analyze the stock market in a way that can benefit an even broader range of stakeholders.

1.2 The information content of stock prices

A firm in the Chapter 11 process not only negotiates with creditors on the amount of debt obligation but also continues its business operations to increase its value over time (Li and Zhong, 2013). It is entirely reasonable to expect that the market's assessment of a bankrupt firm contains information with regard to the firm's business prospects. This notion motivates our study as investors as well as management could benefit from the information contained in the stock price. In addition, researchers have documented that approximately 15 percent of firms that have reorganized and emerged as continuing entities under Chapter 11 ultimately file for bankruptcy protection again (Altman, 2014; Altman and Branch, 2015). This recidivism problem is costly to taxpayers and can be mitigated with an improved bankruptcy process. Understanding the factors that influence successful emergence from bankruptcy is also of interest to bankruptcy courts.

The contribution of this study is two-fold. First, despite a voluminous literature on corporate bankruptcies, relatively little statistical work has been done to fully understand the relation between the stock market implication of a firm's business prospects and its emergence from Chapter 11 bankruptcy as they are seemingly unrelated to each other. Our study is distinguished from previous work (e.g. Eberhart *et al.*, 1999; Dawkins *et al.*, 2007) as it uses the analogy of a European call option to derive the market's assessment of the probability that a firm will emerge from bankruptcy within a certain timeframe. In the remainder of this paper, we refer to this as the "probability of emergence" for convenience. The use of an option pricing model is based on a guideline regarding a dissenting class of unsecured claims to Chapter 11 debtors, known as the absolute priority rule (APR). If the APR is strictly applied, secured creditors will be compensated first followed by bondholders and unsecured suppliers; the claims of shareholders are satisfied last if ever. The value of a firm held by existing shareholders therefore remains zero until the total value of the firm exceeds its debt claims.

The probability of emergence is calculated with the Expected Default Frequency model, more commonly known as the KMV–Merton model. Based on Black and Scholes' (1973) formula, the model utilizes information from the current stock price of a firm to determine the company's probability of default on its liabilities. The use of the Black–Scholes model for

corporate valuation imposes assumptions that are not very realistic with a firm in ordinary business operations. Specifically, this approach requires all of a firm's obligations to be in the form of zero-coupon debt (i.e. no interest payments) with the same maturity date (Leland, 2002)[2]. A debtor operating under the Chapter 11 bankruptcy code, on the other hand, has protection from its creditors with no debt or interest payments during the restructuring process. In other words, a bankrupt firm behaves more like a plain-vanilla call option, rendering the use of the KMV–Merton model more appropriate[3]. To the best of our knowledge, there has been no empirical work applying an option pricing model to the valuation of bankrupt firms while recognizing the above mentioned issues.

Second, we further examine whether this market-based indicator has greater predictive power than do financial statements-based measures also on the recovery rates of unsecured creditors. There has been little attention paid to the factors that influence the recovery rates of unsecured creditors. Because of the APR, equity holders' stake relies largely on the recovery by creditors. This paper is distinct from extant studies on the recovery rate (e.g. Bris *et al.,* 2006; Donovan *et al.,* 2015) in that it not only utilizes the information taken from the financial statements before the bankruptcy filing but also incorporates the market's assessment of a firm. The probability of emergence includes underlying business prospects indicated by stock market participants, which is not found in financial statements. A market-based measure better reflects a bankrupt firm's prospects during the restructuring process than does accounting information.

Our study includes cases filed under Chapter 11 of Title 11 of the United States Code, known as the US Bankruptcy Code, between 1980 and 2016. Our analysis employs the probit regression analysis to validate that the probability of emergence provides superior information content on a firm's business prospects during the restructuring process. To examine the association between the probability of emergence and the unsecured recovery rates, we use a fractional response model. The remainder of this paper is organized as follows. Section 2 describes the current literature relevant to our study. Section 3 shows descriptive statistics of data, such as firm characteristics by sector. Section 3 also describes the option pricing model adopted by this study for market-based firm valuation. Section 4 presents the empirical results and Section 5 concludes the study.

2. Extant literature

2.1 Prediction of corporate bankruptcy

Seminal studies of the prediction of corporate bankruptcy utilize accounting-based measures (e.g. Altman's, 1968 *z*-score and Ohlson's, 1980 *O*-score) while more recent studies also incorporate market-driven variables and sophisticated models to predict the likelihood of bankruptcy. Hillegeist *et al.* (2004) compare the relative information content of accounting-based predictors to a market-based measure of the probability of bankruptcy developed using the Black–Scholes–Merton option-pricing model and found that a market-based model provides significantly more information than the most prominent accounting-based measures. Regardless of the model used, Altman *et al.* (2016) find that most financial distress prediction models are reliable only for short horizons of one to three years; however, measures of solvency, turnover, industry risk, payment behavior and board member characteristics can be significant predictors of bankruptcies for as long as ten years. Other studies investigate bankruptcy from different aspects, such as audit practices, bond rating changes and board of director characteristics (Lennox, 1999; Kim and Nabar, 2007; Darrat *et al.*, 2016).

Contemporary studies investigate other predictors of corporate bankruptcy such as earnings forecasts, accounting audit reports, board of director characteristics and several others. Lennox (1999) evaluates and explains the accuracy and informativeness of audit reports in identifying failing companies and finds that audit reports are noisy indicators of bankruptcy. Kim and Nabar (2007) find that the probability of bankruptcy increases both

before and after bond downgrades and increases before bond upgrades, but not after. Xu *et al.* (2010) find that coordinating supply chain mechanisms are effective in reducing the risk of bankruptcy. Darrat *et al.* (2016) find that having larger boards of directors reduces the risk of bankruptcy for complex firms and the proportion of inside directors on the board is inversely associated with the risk of bankruptcy. James (2016), in the context of strategic bankruptcy, observes that intangible assets and assets that can be efficiently sold in bankruptcy positively influence the likelihood that a firm will file for Chapter 11 and reorganize in a shorter number of years. Finally, Hess and Huettemann (2018) use earnings forecasts and their standard deviations to calculate the probability that future firm losses deplete book equity, ultimately leading to financial distress.

2.2 Factors that influence the successful emergence from corporate bankruptcy

Before emerging from bankruptcy, US debtor companies are required to provide financial and operational projections to the bankruptcy court. However, Michel *et al.* (1998) find that these projections are frequently, and often greatly, overstated. In addition, there was an increased prevalence of companies going bankrupt in the late 1990s and early 2000s. The Bankruptcy Abuse Prevention and Consumer Protection Act of 2005 states that in order for a reorganization plan to be confirmed, the court must make an independent finding that it is feasible and that further reorganization is unlikely. However, unless convincing evidence of the lack of feasibility is presented by interested parties, bankruptcy courts appear to believe that sanctioning the plan as presented is the only and best option (Altman and Branch, 2015). Altman *et al.* (2009) document that firms that filed second bankruptcy petitions were both significantly less profitable and more highly leveraged than those that emerged and continued as going concerns. The tendency for companies to emerge from Chapter 11 with too much debt and too little profitability causes concern for the bankruptcy process. Altman (2014) and Altman and Branch (2015), when studying the recidivism of bankrupt firms filing multiple times, suggest that a credible distress prediction technique can effectively predict the future success of firms emerging from bankruptcy and can be used by bankruptcy courts to assess the feasibility of reorganization plans.

Franks and Loranth (2013) document how the allocation of control rights between secured and unsecured creditors in bankruptcy and the compensation scheme of the agent managing the bankruptcy process influences outcomes. Bryan *et al.* (2014) study the association between corporate fraud and bankruptcy and find that fraud is positively associated with bankruptcy filings, indicative of fraudulent reporting being used by managers as attempts to avoid or delay bankruptcy. These actions decrease the ability of the firm to emerge from bankruptcy. Altman (2014) studies the role of the distressed debt market and its investors in the outcome of the bankruptcy process. LoPucki and Doherty (2015) study conditions that best predict companies' survival prospects and find that reorganizations assigned to more experienced judges, companies with prepackaged plans or debtor-in-possession (DIP) loans, companies that file in periods of low interest rates, larger companies, manufacturing companies and companies with positive pre-filing operating income are more likely to successfully emerge.

Donovan *et al.* (2015) examine the relationship between accounting conservatism and creditor recover rates for firms in default and find that conservative firms have shorter bankruptcy resolution, a significantly higher probability of emerging from bankruptcy and higher recovery rates for creditors. In a related study, Fisher *et al.* (2019) study the impact of earnings management prior to bankruptcy filing on the passage of firms through Chapter 11 and find that earnings management prior to bankruptcy significantly reduces the likelihood of plan confirmation and emergence from Chapter 11. They also find that stressed firms are less likely to have their plans confirmed while the auditor choice (Big 4 vs non-Big 4) positively affects the probability of plan confirmation as well as the likelihood of emergence from bankruptcy.

Ivashina *et al.* (2016) find that firms with higher debt concentration at the start of the case are more likely to file prearranged bankruptcy plans, to move quickly through the restructuring process and to emerge successfully as independent going concerns. Xia *et al.* (2016) show that an increase in alliance partners, institutional investors and securities analysts following a bankrupt firm predicts the firm's reorganization outcome. Olsen and Tamm (2017) examine changes in corporate governance structure during the bankruptcy process and find that the changes in governance structure do not alter the likelihood that a firm will emerge. Campello *et al.* (2018) find that firms with a large percentage of their workforce in unions experience longer proceedings in bankruptcy court, with more bankruptcy emergences and subsequent refillings. Finally, Arora (2018) finds that the effort of financially linked independent directors increases the likelihood of emergence as well as improved access to financial resources.

3. Data and methodology

3.1 Data collection and summary statistics

Chapter 11 of the US Bankruptcy Code specifically pertains to the reorganization of a business entity's debt. A firm is classified as successfully emerged if at least one member of the corporate group (e.g. a subsidiary) is successfully reorganized under a confirmed Chapter 11 Plan of Reorganization approved by a court with consent of the creditors, or sold under Bankruptcy Code §363 but continues to operate its business. If a company is acquired by another company, it is also deemed to have emerged as long as it continues to operate as a separate business. Conversely, if the acquiree's assets are integrated into the existing business of the acquirer or merged into a newly formed entity where the merger partner contributed a substantial portion of the assets, it is considered a liquidation.

Our analysis includes Chapter 11 cases filed between 1980 and 2016, with the majority of the data coming from the UCLA – LoPucki Bankruptcy Research Database, which we have supplemented with hand-collected data from the full bankruptcy documents obtained through New Generation Research Inc. One of the requirements posed by the nature of our analysis is that financial statements immediately prior to the Chapter 11 filing are available. The annual financial statements data for a total of 267 Chapter 11 cases filed during the sample period are obtained from Compustat. The use of the KMV–Merton model also requires stock prices surrounding the bankruptcy filing dates, and the data come from the Center for Research in Security Prices (CRSP)[4]. In addition, the percent of institutional ownership at each firm is considered as a possible factor that causes higher volatility for some of the stock. The percent of shares outstanding held by institutional owners for each firm is obtained from Thomson-Reuters Institutional Ownership. Our study only includes Chapter 11 firms that meet all of these conditions. We ultimately have a total of 152 firms that can be used for our regression analysis[5]. Table I presents a summary of the firm characteristics divided into nine sectors based on the primary SIC code (SSIC1).

The duration of the Chapter 11 process is the number of days from the date when a bankruptcy case was filed to the final resolution date of the process. For the cases where the Chapter 11 Plan of Reorganization was eventually confirmed by a court, the resolution date is the date when a court order approving the plan was issued. If the majority of the assets of a bankrupt company were sold under Bankruptcy Code §363, the resolution date is the confirmation date of the Plan of Liquidation. If a case is converted to Chapter 7, its conversion date is used as the resolution date[6]. The duration ranges from 35 days to 3,955 days in our final sample while the average duration is relatively short in the mining and services sectors.

The average market capitalization (size) of a firm is particularly large in the manufacturing sector ($289m), followed by the transportation, communications, etc. ($166m). Profitability is a firm's earnings before interest, taxes, depreciation and amortization (EBITDA) divided by its total assets. This variable represents operating efficiency apart from tax and leveraging

Outcome	No. of cases	Pct.	Min.	Max.	Mean	SD
Agriculture, forestry and fishing	1	0.7%				
Duration of Ch. 11 process (days)			100	100	100	na
Market capitalization (in millions of dollar)			50.70	50.70	50.70	na
Profitability (%)			4.9	4.9	4.9	na
Tangibility (%)			93.1	93.1	93.1	na
Institutional ownership (%)			48.3	48.3	48.3	na
Shares outstanding (in millions)			66.7	66.7	66.7	na
Stock price ($/share)			0.76	0.76	0.76	na
Mining	9	5.9%				
Duration of Ch. 11 process (days)			38	684	269	191
Market capitalization (in millions of dollar)			0	46.08	9.99	16.39
Profitability (%)			−67.7	17.7	−3.0	25.0
Tangibility (%)			88.6	100	98.3	3.8
Institutional ownership (%)			8.8	68.4	24.5	18.9
Shares outstanding (in millions)			5.1	285.1	54.6	87.6
Stock price ($/share)			0	6.63	0.87	2.12
Construction	4	2.6%				
Duration of Ch. 11 process (days)			62	956	684	417
Market capitalization (in millions of dollar)			1.06	41.55	19.08	21.08
Profitability (%)			−6.7	6.4	0.9	5.6
Tangibility (%)			90.3	100	97.2	4.6
Institutional ownership (%)			4.2	32.8	20.8	13.5
Shares outstanding (in millions)			5.7	33.2	13.8	13.0
Stock price ($/share)			0.16	3.62	1.30	1.63
Manufacturing	46	30.3%				
Duration of Ch. 11 process (days)			35	3,955	677	696
Market capitalization (in millions of dollar)			0	9,449	289	1,395
Profitability (%)			−40.7	24.2	4.5	11.3
Tangibility (%)			31.1	100	89.0	15.4
Institutional ownership (%)			0.1	94.9	38.1	25.6
Shares outstanding (in millions)			4.2	561.2	53.5	89.5
Stock price ($/share)			0	39	3.43	8.16
Transportation, communications, etc.	33	21.7%				
Duration of Ch. 11 process (days)			65	2,994	789	651
Market capitalization (in millions of dollar)			0	4,022	166	712
Profitability (%)			−30.1	9.4	−2.3	9.8
Tangibility (%)			45.9	100	91.5	15.4
Institutional ownership (%)			1.2	87.7	37.9	26.2
Shares outstanding (in millions)			10.6	627.7	76.2	127.9
Stock price ($/share)			0	18.87	1.33	3.79
Wholesale trade	10	6.6%				
Duration of Ch. 11 process (days)			36	1,263	444	333
Market capitalization (in millions of dollar)			0	60.36	9.65	18.81
Profitability (%)			−4.4	34.1	7.3	10.6
Tangibility (%)			52.3	100	88.2	16.0
Institutional ownership (%)			2.9	77.4	23.9	22.4
Shares outstanding (in millions)			2.4	75.8	25.5	22.5
Stock price ($/share)			0	2.06	0.33	0.64
Retail trade	8	5.3%				
Duration of Ch. 11 process (days)			274	1,508	883	484
Market capitalization (in millions of dollar)			0	40.76	19.28	15.62
Profitability (%)			−4.4	11.4	6.0	5.0
Tangibility (%)			68.1	100	91.1	13.0
Institutional ownership (%)			1.3	69.7	36.5	21.8

(*continued*)

Table I.
Summary of firm characteristics by sector

Outcome	No. of cases	Pct.	Min.	Max.	Mean	SD
Shares outstanding (in millions)			8.5	100.3	36.3	32.6
Stock price ($/share)			0	2.12	0.69	0.72
Finance, insurance and real estate	24	15.8%				
Duration of Ch. 11 process (days)			116	1,917	708	473
Market capitalization (in millions of dollar)			0	503.59	34.02	105.07
Profitability (%)			−21.8	15.6	0.9	8.7
Tangibility (%)			82.9	100	98.1	3.9
Institutional ownership (%)			1.7	63.7	22.3	15.8
Shares outstanding (in millions)			1.7	751.6	55.5	149.8
Stock price ($/share)			0	2.46	0.38	0.57
Services	17	11.2%				
Duration of Ch. 11 process (days)			42	1,142	376	308
Market capitalization (in millions of dollar)			0	236.86	24.09	56.81
Profitability (%)			−115.8	42.6	1.9	35.6
Tangibility (%)			33.9	100	82.1	23.8
Institutional ownership (%)			0.1	68.9	27.5	22.7
Shares outstanding (in millions)			11.3	428.8	96.1	134.6
Stock price ($/share)			0	11.10	1.02	2.67
Total	152	100%				

Notes: The sample consists of the firms associated with 152 Chapter 11 filings between 1980 and 2016. Firms are divided into nine sectors based on the primary SIC code (SSIC1). Duration of Ch. 11 process is the number of days from the date when the bankruptcy case was filed to the final resolution date. Market capitalization is the number of a firm's shares outstanding (in millions) multiplied by the share price ($) immediately before the filing date. Profitability is defined as the firm's EBITDA divided by its total assets. Tangibility represents the total book value of the firm's plant, property and equipment divided by its total assets. Institutional ownership is the percent of shares outstanding held by institutional owners. Shares outstanding is the number of a firm's common shares outstanding is in millions. Stock price is the share price immediately before the filing date

Table I.

factors. Tangibility represents the total book value of a firm's plant, property and equipment divided by its total assets. As assets become more tangible, creditors can recover more of their investment through liquidation. The percent of institutional ownership is particularly high in the manufacturing sector (38.1 percent) and the retail trade sector (36.5 percent). Shares outstanding is the number of a firm's common shares outstanding in millions immediately before the filing date. Stock price is the share price at the point when the probability of emergence is calculated.

Table II shows a breakdown of the cases by filing characteristics. As discussed earlier, the APR is often violated during the Chapter 11 process, significantly influencing the outcome of the Chapter 11 cases[7]. Following Eberhart *et al.* (1999) and Li and Zhong (2013), we control the effect of the APR violation by including two dummy variables in our regression analysis.

	Prepackaged	DIP loan	Unsecured committee	Voluntary petition
Yes	141	128	138	143
No	11	24	14	9
% of Yes	92.8	84.2	90.8	94.1

Notes: The sample consists of the firms associated with 152 Chapter 11 filings between 1980 and 2016. Voluntary petition indicates whether the case was filed voluntarily by the firm. Unsecured committee shows whether an official committee representing the unsecured creditors was appointed. Prepackaged means that the case was negotiated before filing and prepackaged. DIP loan shows whether a DIP loan was approved by the court

Table II.
Filing characteristics of the chapter 11 cases

The first one indicates whether the case is a prepackaged filing; a case is said to be prepackaged if the debtor drafted the detailed plan before filing the case and claimed to have obtained the acceptances from creditors necessary for consensual confirmation. Prepackaged cases tend to have better stock price performance during the Chapter 11 process. Table II indicates that 11 out of 152 cases were either not prepackaged or negotiated before filing but the acceptances necessary for confirmation were not obtained.

The second variable is associated with a DIP loan, which is financing made available to the bankrupt firm during the bankruptcy process. To fund the debtor and facilitate its restructuring process, the court approves a DIP loan pursuant to Bankruptcy Code §364. DIP loans could act as deterrents to APR violations. The DIP loan was approved by the court for 128 out of 152 cases used in our study. Our regression analysis also includes two additional variables related to how Chapter 11 cases are filed. One of them is whether an official committee representing the unsecured creditors was appointed by the court while the other indicates if a bankruptcy case was voluntarily filed by the obligor.

3.2 Calculating the probability of emergence

The probability of emergence is calculated with the KMV–Merton model. As described in Section 1, a firm in the restructuring process provides an ideal setting for the application of the Black–Scholes model that poses unrealistic assumptions when used for corporate valuation. In the KMV–Merton model, the market value of the firm's assets follows a geometric Brownian motion process[8]. Applying the Black–Scholes formula, the relationship between the firm's asset value and its equity value at time τ can be expressed as the following:

$$V_E = E[\max(V_A - D, 0)] = V_A \cdot N[d_1] - e^{-\mathrm{rT}} D \cdot N[d_2], \tag{1}$$

where:

$$d_1 = \frac{\ln V_A - \ln D + \left(r + \sigma_A^2/2\right)(T-\tau)}{\sigma_A \sqrt{(T-\tau)}},$$

$$d_2 = \frac{\ln V_A - \ln D + \left(r - \sigma_A^2/2\right)(T-\tau)}{\sigma_A \sqrt{(T-\tau)}} = d_1 - \sigma_A \sqrt{T-\tau},$$

where $N[\cdot]$ is the cumulative normal distribution; V_E the firm's equity value set as the firm's market capitalization immediately before its Chapter 11 filing; D the firm's default point, which is the critical threshold set as the firm's total current liabilities plus total long-term debt; r the one-year Treasury Bill rate.

$T-\tau$ is the expected duration that the firm is expected to stay in bankruptcy. Under Chapter 11 protection, the firm is allowed to continue its operations and is expected to increase its value over time. As such, it is not appropriate to set an artificial time limit for the restructuring process of any firm. Nevertheless, bankrupt firms are often liquidated through asset sales under Code §363 during the Chapter 11 process or the case that was initially filed under Chapter 11 is later converted to Chapter 7. The median duration between the filing date and the resolution date for our final sample is 485 days and it is used as a proxy for the time to expiry[9].

It should be clear that the purpose of using the KMV–Merton model is not to estimate the firm's equity value ($= V_E$), which can be easily approximated as the firm's market capitalization; it is to solve backwards for the volatility of the underlying asset implied by V_E. Following Goyal and Wang (2013), we have calculated the firm's implied asset value and

the implied asset volatility in the way described below. An iteration procedure, such as the Newton–Raphson method, can be used to estimate implied values:

(1) The first iterative procedure is to estimate the implied asset value of each firm prior to bankruptcy. At this point, the standard deviation of the firm's 20-day historical stock price returns is used as a proxy for the asset volatility ($=\sigma_A$). Given the already low market capitalization of the firm ($=V_E$) along with the high volatility of the underlying asset immediately prior to bankruptcy, the KMV–Merton model would keep the firm's implied asset value ($=V_A$) very low. That is, the option is deep out of the money, which intuitively makes sense especially for a firm on the verge of bankruptcy. In the post-bankruptcy period, the firm's implied asset value based on the relatively low volatility of the underlying asset will be higher. However, this does not necessarily mean that the option is in the money post-bankruptcy.

(2) Subsequently, we calculate the log returns on each firm's implied asset value for the following 20 consecutive trading days. These log returns are then used to generate the second estimate of the asset volatility ($=\sigma_A$).

(3) Finally, based on the firm's market capitalization ($=V_E$), the implied asset volatility ($=\sigma_A$), time horizon ($=T-\tau$) and the drift rate ($=\mu_i$), the second implied asset value of the firm ($=V_A$) is estimated with the KMV–Merton model and the second iterative procedure. Note that μ_i is the average log-return of V_A and it replaces r.

The probability that the value of the firm exceeds the aggregated value of existing debt claims at time T can be expressed in terms of the cumulative normal distribution:

$$\text{Probability}\left(V_{A,T} > D_T\right) = N[d_2]. \tag{2}$$

$N[d_2]$ in Equation (2) represents the probability of emergence, where d_2 measures how far the firm's value is from the default point at a given point of time. If the firm's value increases, ceteris paribus, the distance between them will increase. Conversely, the distance shortens as the default point increases. While these relationships are obvious, one variable that makes this approach distinct from accounting-based measures is volatility. Higher volatility leads to a higher d_2, subsequently making a probability of emergence higher. This is analogous to the positive association between the value of a plain-vanilla option and the volatility of its underlying asset price returns.

4. Empirical results

4.1 Probability of emergence and Chapter 11 outcome

The reasonableness of the probability of emergence estimated with the KMV–Merton model is verified through a comparison against the actual outcomes of Chapter 11 bankruptcy cases. Because the Chapter 11 outcomes are binary data, using probit regression models appears to be an ideal method for our analysis. The following equation includes all the independent variables tested in our study:

$$\begin{aligned}\Pr(Emerge_i = 1) = \Phi\big[&\beta_0 + \beta_1 Probability_i + \beta_2 Profitability_i + \beta_3 Tangibility_i + \beta_4 IntOwner_i \\ &+ \beta_5 Recession_i + \beta_6 Prepackaged_i + \beta_7 DIPLoan_i \\ &+ \beta_8 Committee_i + \beta_9 Voluntary_i + \sum \gamma_k Sector_{k,i}\big].\end{aligned} \tag{3}$$

The dependent variable is the probability that firm i successfully emerges from the Chapter 11 process. Φ represents the cumulative normal distribution. $Probability_i$ indicates the probability of emergence as described in Section 3.2. Profitability and tangibility described

in Section 3.1 are both in Equation (3). On the other hand, a firm's leverage level that is one of the standard variables used in the literature is not explicitly included in our regression models as it is indirectly incorporated in the KMV–Merton model.

Unobserved sector heterogeneity is managed by adding sector dummy variables denoted $Sector_{k,i}$, where $k = 1, 2, \ldots, 9$. Each of these variables takes on the value of 1 if a firm belongs to a specific sector as defined by the primary SIC code, or 0 otherwise. To consider macroeconomic conditions during the restructuring processes, the model includes $Recession_i$ that takes on the value of 1 if the Chapter 11 filing date is included in a recession period as defined by the National Bureau of Economic Research, or 0 otherwise[10]. The model includes other explanatory variables associated with firm characteristics and how the restructuring process was handled.

For many firms, CRSP maintains stock prices even after their Chapter 11 filings. To see if there is any difference in accuracy due to different specifications, the probability of emergence was estimated based on: (A) the pre-bankruptcy stock price data; and (B) the post-bankruptcy stock price data. Specifically, the probability for each firm in the specification (A) is calculated based on the stock prices observed immediately before the Chapter 11 filing dates [−41, 0], where the day "0" represents the filing date[11]. As for specification (B), the probability for each firm is calculated based on the stock prices observed immediately after the Chapter 11 filing dates [0, +41]. In some cases, however, there are not sufficient post-filing prices for the estimation of the probability. For example, CRSP might have ceased to maintain the prices of a firm 15 days after its bankruptcy filing. When this occurs, the estimation is based on a combination of the pre-filing and post-filing prices. In either case, all the estimates of the probability of emergence are based on the stock price returns prior to the final resolution date of the case.

Panel A of Table III shows the coefficient estimates and p-values for several models, each of which includes the probability of emergence estimated with specification (A) while Panel B involves the probability of emergence based on specification (B). The probability of emergence is the only variable that reflects the market assessment of a firm and is our primary interest in this study. As shown in Panel A, this variable is statistically significant at a 5 percent level in both Models (1) and (3). When variables associated with firm characteristics and economic conditions, however, the variable is significant only at a 10 percent level.

In sharp contrast, Panel B presents that the probability of emergence estimated based on specification (B) is a statistically significant variable at a significance level of 1 percent in all of the models. Though not reported in the table, the marginal effects of this particular variable are 0.625, 0.667, 0.720 and 0.684 in Models (1), (2), (3) and (4), respectively. This means that the probability that firm i successfully emerges from the Chapter 11 process increases by a range of 0.63–0.72 percent for a 1 percent increase in the probably of emergence. Meanwhile, most of the other variables are not found to be statistically significant variables in the tests. The only variable that is consistently significant in multiple models in Panel B is the prepackaged filing. This should not be surprising because, if the creditors have already accepted a detailed plan of reorganization presented by debtor before filing, it significantly increases the chance that the firm will emerge from bankruptcy within a reasonable amount of time. Overall, the result suggests that the probability of emergence provides superior information content on a firm's business prospects during the restructuring process.

It is interesting that the probability of emergence estimated with specification (B) has substantially greater explanatory power than does that with specification (A). It is possible that the prices of some of the stock become excessively volatile immediately before its Chapter 11 filing, making the estimate of the probability of emergence upwardly biased. In fact, the average of the probabilities of emergence with specification (A) is 69.4 percent, more than 20 percentage points higher than 48.8 percent based on specification (B). One possible

Dep. Var.: emerged (Y/N)	(1)	(2)	(3)	(4)
Panel A: probabilities of emergence estimated immediately before filing dates				
Probability of emergence (%)	0.989 (0.034)**	0.926 (0.089)*	0.888 (0.033)**	0.883 (0.061)*
Profitability (%)		2.177 (0.054)*		2.515 (0.081)*
Tangibility (%)		0.425 (0.492)		1.237 (0.222)
Institutional ownership (%)		0.087 (0.859)		0.076 (0.888)
NBER recession (Y/N)		−0.349 (0.209)		−0.374 (0.270)
Prepackaged filing (Y/N)			0.836 (0.116)	0.515 (0.576)
DIP loan approved (Y/N)			0.207 (0.524)	−0.019 (0.939)
Unsecured committee (Y/N)			0.638 (0.916)	−0.656 (0.423)
Voluntary petition (Y/N)			0.521 (0.295)	0.599 (0.310)
Number of observations	112	112	112	112
Sector-fixed effect included	Y	Y	Y	Y
McFadden's R^2	0.129	0.179	0.146	0.202
Panel B: probabilities of emergence estimated immediately after filing dates				
Probability of emergence (%)	1.567 (< 0.001)***	1.695 (< 0.001)***	1.806 (< 0.001)***	1.716 (< 0.001)***
Profitability (%)		2.943 (0.162)		2.574 (0.272)
Tangibility (%)		0.833 (0.117)		2.806 (0.005)***
Institutional ownership (%)		0.733 (0.110)		0.320 (0.545)
NBER recession (Y/N)		−0.463 (0.090)*		−0.561 (0.094)*
Prepackaged filing (Y/N)			1.798 (0.023)**	2.062 (0.003)***
DIP loan approved (Y/N)			0.899 (0.045)**	0.647 (0.137)
Unsecured committee (Y/N)			0.616 (< 0.001)***	0.026 (0.871)
Voluntary petition (Y/N)			0.858 (0.375)	0.960 (0.341)
Number of observations	112	112	112	112
Sector-fixed effect included	Y	Y	Y	Y
McFadden's R^2	0.247	0.313	0.307	0.365

Notes: The coefficient estimates of probit models are shown with *p*-values in parentheses. The dependent variable takes on a value of 1 if firm *i* successfully emerged from its Chapter 11 process, or 0 otherwise. Probability of emergence indicates the likelihood that firm *i* successfully emerges from bankruptcy estimated by the KMV–Merton model. Profitability is defined as the firm's EBITDA divided by its total assets. Tangibility represents the total book value of the firm's plant, property and equipment divided by its total assets. Institutional ownership is the percent of shares outstanding held by institutional owners. NBER recession takes on the value of 1 if the Chapter 11 filing date is included in a recession period as defined by the National Bureau of Economic Research (NBER), or 0 otherwise. Prepackaged filing takes on a value of 1 if the case was prepackaged, or 0 otherwise. DIP loan approved takes on a value of 1 if the DIP loan was approved by the court, or 0 otherwise. Unsecured committee takes on a value of 1 if an official committee that represents the unsecured creditors was appointed by the court, or 0 otherwise. Voluntary petition takes on a value of 1 if the case was filed voluntarily, or 0 otherwise. Although not presented in the table, dummy variables, each of which takes on the value of 1 if a firm belongs to the specific sector (e.g. construction) based on the primary SIC code (SSIC1), are included in all the models. Standard errors allow for clustering at the sector level. *,**,***Significant at the 10, 5 and 1 percent levels, respectively

Table III.
Probability of emergence and outcome of Chapter 11 process

reason for this is that institutional owners required to invest prudently (e.g. life insurance companies, pension funds) tend to sell off their shares immediately before bankruptcy filing dates[12]. This certainly could lead to higher volatility. However, this explanation may not be well supported empirically as the percent of institutional ownership is statistically insignificant at a 10 percent level in both Models (2) and (4), regardless of whether the probability of emergence is estimated with specification (A) or (B).

Another possible explanation is that stock prices after the bankruptcy filings are simply more updated and better reflect a firm's current business prospects. Regardless of the rationale, a comparison of the results in Panels A and B suggests that having the post-bankruptcy stock price information is crucial to accurately estimate the probability of emergence. For this reason, our analysis in Section 4.2 focuses on the probability of emergence estimated with specification (B).

4.2 Additional analysis – unsecured recovery rate

The primary purpose of our additional analysis is to see whether the probability of emergence has predicting power superior to the variables simply retrieved from a financial statement. First, descriptive statistics of recovery rates in Chapter 11 cases with respect to different classifications of creditors are shown in Table IV. The total recovery rate is calculated as the total dollar amounts distributed to both the secured and unsecured creditors divided by the total amount of their initial claims (Panel A). Likewise, the unsecured recovery rate is the percentage of the disbursement made to the unsecured creditors over the amount of claims made by the unsecured creditors (Panel B).

It should be expected that the average recovery rate of the firms that were successfully reorganized is significantly higher than that of the firms that were ultimately liquidated. It is also reasonable that the unsecured recovery rates are lower than the total recovery rates, regardless of whether the firms eventually emerged from bankruptcy or were liquidated. A firm's financial obligations to secured creditors were normally collateralized in certain forms.

Since the recovery rate must be an exact fraction within the interval of 0 and 1, a fractional response model (Papke and Wooldridge, 1996) is utilized for our analysis. Using a traditional probit or logit procedure would unavoidably suffer from econometrical problems because either of these models converts a fractional value of the dependent variable into a value of either 0 or 1. For example, an observation whose probability equal to or greater than 0.5 would have a value of 1 for its dependent variable, and otherwise a value of 0. Equation (4) shows the regression model including all of the possible independent variables examined in our analysis:

$$\begin{aligned} E(Recovery_i|\mathbf{X}) = {} & \beta_0 + \beta_1 Probability_i + \beta_2 Excess_i + \beta_3 Log|Excess_i| \times DumExcess_i \\ & + \beta_4 Financial_i + \beta_5 Profitability_i + \beta_6 Tangibility_i + \beta_7 Recession_i \\ & + \beta_8 Prepackaged_i + \beta_9 DIPLoan_i + \beta_{10} Committee_i + \beta_{11} Voluntary_i. \quad (4) \end{aligned}$$

The dependent variable represents the expected recovery rate with respect to unsecured creditors of firm i conditional on a vector of all the explanatory variables, $\mathbf{X}$. We only focus on the unsecured recovery rate. This is because a firm's financial obligation to secured creditors has been already collateralized prior to the Chapter 11 filing date, creating nontrivial bias in testing the relation between a firm's recovery rate and underlying business risk.

Outcome	No. of cases	Recovery rate Min. (%)	Max. (%)	Mean (%)	SD
Panel A: summary of the total recovery rate					
Emerged	25	12.1	100.0	58.2	0.268
Liquidated	8	3.0	62.6	33.5	0.268
Total	33	3.0	100.0	52.2	0.286
Panel B: summary of the unsecured recovery rate					
Emerged	25	0.0	100.0	43.8	0.356
Liquidated	8	3.0	62.6	22.7	0.247
Total	33	0.0	100.0	38.7	0.342

Notes: The sample consists of 33 Chapter 11 filings between 1980 and 2016. There are two categories of outcome: emerged or reorganized; and liquidated. The recovery rate is calculated as the total dollar amounts distributed to the relevant creditors divided by the total amount of their initial claims

Table IV. Historical recovery rate by outcome and type of claim

Based on Equation (4), we access the explanatory power of the probability of emergence on the dependent variable by comparing against two alternative variables. One of them, $Excess_i$, represents the excess value of firm i that is calculated as the total assets reported in the last annual financial statement before the bankruptcy filing minus the sum of the short-term and long-term debt. The other variable is $Log|Excess_i| \times DumExcess_i$, which is the product of the natural logarithm of the absolute value of $Excess_i$ and a dummy variable that takes on a value of 1 if $Excess_i$ is greater than 0. An interaction term is used because an excess value can be negative. All other variables in Equation (4) are as defined in Equation (3). The empirical results from the fractional response regressions are shown in Table V.

As explained earlier, the probability of emergence is estimated with specification (B). Models (1), (2) and (5) test this variable combined with firm characteristics variables and variables associated to how the case was filed. The result shows that the probability of emergence is statistically significant at a 5 percent level, regardless of whether it is combined with firm characteristics variables in Model (1), with Chapter 11 filing variables in Model (2), or with all of them in Model (5). The marginal effects of this particular variable are 0.470 in Model (1), 0.533 in Model (2) and 0.562 in Model (5), indicating that the unsecured recovery rate increases by a range of 0.47–0.56 percent for a 1 percent increase in the probability of emergence. On the other hand, Models (3) and (4) are associated with each of the two alternative variables, the excess value and the adjusted logarithm of the excess

Dep. Var.: unsecured recovery rate	(1)	(2)	(3)	(4)	(5)
Probability of emergence (%)	1.276 (0.040)**	1.448 (0.028)**			1.608 (0.047)**
Excess value			0.000 (0.655)		
Adj. log. excess value				0.119 (0.291)	
Financial sector (Y/N)	1.170 (0.399)				1.258 (0.389)
Profitability (%)	3.231 (0.423)				4.403 (0.286)
Tangibility (%)	5.268 (0.116)				7.095 (0.088)*
NBER recession (Y/N)	−0.111 (0.833)				−0.481 (0.408)
Prepackaged filing (Y/N)		−1.463 (0.404)	−0.883 (0.481)	−0.793 (0.540)	0.518 (0.821)
DIP loan approved (Y/N)		0.492 (0.625)	−0.142 (0.860)	−0.212 (0.794)	−0.108 (0.935)
Unsecured committee (Y/N)		−0.698 (0.526)	−0.122 (0.898)	−0.177 (0.854)	−1.905 (0.212)
Voluntary petition (Y/N)		2.272 (0.272)	1.539 (0.367)	1.449 (0.411)	4.101 (0.094)
Number of observations	33	33	33	33	33

Notes: The coefficient estimates of fractional response models are shown with p-values in parentheses. The dependent variable is the unsecured recovery rate of firm i. Probability of emergence indicates the likelihood that firm i successfully emerges from bankruptcy estimated by the KMV–Merton model. Excess value is the total assets reported in the last annual financial statement before the filing minus the sum of the short-term and long-term debt. Adj. log. excess value is the natural logarithm of the absolute value of the excess value multiplied by a dummy variable that takes on a value of 1 if the excess value is greater than 0. Financial sector takes on the value of 1 if a firm belongs to the financial sector based on the primary SIC code (SSIC1), or 0 otherwise. Profitability is defined as a firm's EBITDA divided by its total assets. Tangibility represents the total book value of the firm's plant, property and equipment divided by its total assets. NBER recession takes on the value of 1 if the Chapter 11 filing date is included in a recession period as defined by the National Bureau of Economic Research (NBER), or 0 otherwise. Prepackaged filing takes on a value of 1 if the case was prepackaged, or 0 otherwise. DIP loan approved takes on a value of 1 if the DIP loan was approved by the court, or 0 otherwise. Unsecured committee takes on a value of 1 if an official committee that represents the unsecured creditors was appointed by the court, or 0 otherwise. Voluntary petition takes on a value of 1 if the case was filed voluntarily, or 0 otherwise. *,**Significant at the 10 and 5 percent levels, respectively

Table V.
Probability of emergence and unsecured recovery rate

value, in place of the probability of emergence. In our test, neither of them is found statistically significant.

The test statistics in both Tables III and V depend, to some extent, on the model specifications. For example, adjusting the observation window for stock price returns or the time to expiry necessary for the option pricing model could slightly change the results. Nevertheless, these changes are not significant enough to alter our main findings in this paper. Stock market provides insight beyond that obtained from financial statements, and our analysis statistically demonstrates that the probability of emergence can be a useful tool to estimate a firm' ability to successfully emerge from bankruptcy.

5. Conclusion

Using the analogy of a European call option, this study estimates the probability that a firm will emerge from Chapter 11 bankruptcy. A firm in the restructuring process provides an ideal setting for the application of the KMV–Merton model since the value of the firm held by shareholders remains zero until the firm's total value exceeds debt claims. Termed the probability of emergence, this new measure introduced in this paper is verified against the actual outcomes of bankruptcy cases using a probit regression analysis. Our finding confirms that post-bankruptcy stock prices contain information that significantly predicts the probability of successful emergence. Furthermore, we examine the predictive power of the probability of emergence over the recovery rate of the claims of unsecured creditors. Our empirical test using a fractional response model suggests the probability of emergence has better predictive power on the unsecured recovery rate than do some accounting-based measures.

Our study reaffirms that the stock market contains much information about the financial health and business prospects of publicly traded companies. This is the case even after a firm goes into the Chapter 11 restructuring process. Understanding the relationship between the stock market implication of a bankrupt firm and the firm's successful emergence from bankruptcy is beneficial for investors, firm stakeholders and management. The factors that influence successful emergence from bankruptcy are of interest also to bankruptcy courts as repetitive bankruptcy filings can be costly for society. We hope that the findings in this paper will serve as motivation for further research on corporate bankruptcy.

Notes

1. Firm value is defined as the value of the firm that is relevant to all types of investors. Firm value is calculated as the sum of the market values of equity, debt and capitalized leases. Whenever the market value of debt is unavailable, the book value of debt is substituted in many studies.
2. The legitimacy of default risk estimate using the option pricing model has been examined also by Bharath and Shumway (2004) and Conrad *et al.* (2012) among others.
3. Li and Zhong (2013) demonstrate that the Black–Scholes model has the correct properties to value a firm in the Chapter 11 process.
4. Although many stocks are delisted from major exchanges after Chapter 11 filings, some of them resume trading on Pink Sheets, an over-the-counter, electronic quotation system operated by OTC Markets Group Inc. For example, former General Motors Corporation was renamed Motors Liquidation Company shortly after its bankruptcy filing in June 2009 and its stocks started trading on Pink Sheets under the new ticker symbol "MTLQQ."
5. Although the full data obtained from LBRD and NGR include the Chapter 11 cases associated with a total of 35 repeat filers, our final sample only includes first-time filings.
6. Bris *et al.* (2006) conclude that a Chapter 7 procedure takes almost as long to resolve as Chapter 11 cases with lower recovery rates than does a comparable Chapter 11 procedure.

7. Franks and Torous (1989) report that the APR violation affects the disbursement of the firm's assets in favor of equity holders.
8. $\Delta V_A = \mu V_A \Delta t + \sigma_A V_A \varepsilon \sqrt{\Delta t}$ where V_A is the firm's asset value while μ and σ_A are the asset value's drift rate and variance rate, respectively. $\varepsilon \sqrt{\Delta t}$ represents a standard Wiener process.
9. Goyal and Wang (2013) set the forecast horizon, T, to one year when estimating annual default probabilities.
10. Platt and Platt (2002) note that timing of the restructuring process plays a large part as the state of the economy affects outcomes.
11. In total, 42 consecutive trading days are necessary to estimate the implied asset values for 21 consecutive trading days, which are then required to calculate the probability of emergence with respect to each firm.
12. Dawkins *et al.* (2007) likewise attribute negative abnormal returns during the filing period to the activities by large, and arguably sophisticated, investors.

References

Altman, E. (1968), "Financial ratios, discriminant analysis and the prediction of corporate bankruptcy", *The Journal of Finance*, Vol. 23 No. 4, pp. 589-609.

Altman, E. (1984), "A further empirical investigation of the bankruptcy cost question", *The Journal of Finance*, Vol. 39 No. 4, pp. 1067-1089.

Altman, E. (2014), "Revisiting the recidivism – Chapter 22 phenomenon in the US bankruptcy system", *Brooklyn Journal of Corporate, Financial & Commercial Law*, Vol. 8 No. 2, pp. 253-277.

Altman, E. and Branch, B. (2015), "The bankruptcy system's Chapter 22 recidivism problem: how serious is it?", *The Financial Review*, Vol. 50 No. 1, pp. 1-26.

Altman, E., Kant, T. and Rattanaruengyot, T. (2009), "Post-Chapter 11 bankruptcy performance: avoiding Chapter 22", *Journal of Applied Corporate Finance*, Vol. 21 No. 3, pp. 53-64.

Altman, E., Iwanicz-Drozdowska, M., Laitinen, E. and Suvas, A. (2016), "Financial and nonfinancial variables as long-horizon predictors of bankruptcy", *Journal of Credit Risk*, Vol. 12 No. 4, pp. 49-78.

Arora, P. (2018), "Financially linked independent directors and bankruptcy reemergence: the role of director effort", *Journal of Management*, Vol. 44 No. 7, pp. 2665-2689.

Bharath, S. and Shumway, T. (2004), "Forecasting default with the KMV-Merton model", *2006 American Finance Association Annual Conference, Boston, MA, January 6-8.*

Black, F. and Scholes, M. (1973), "The pricing of options and corporate liabilities", *The Journal of Political Economy*, Vol. 81 No. 3, pp. 637-654.

Bris, A., Welch, I. and Zhu, N. (2006), "The costs of bankruptcy: Chapter 7 liquidation versus Chapter 11 reorganization", *The Journal of Finance*, Vol. 61 No. 3, pp. 1253-1303.

Bryan, D., Janes, T. and Tiras, S. (2014), "The role that fraud has on bankruptcy and bankruptcy emergence", *Journal of Forensic & Investigative Accounting*, Vol. 6 No. 2, pp. 126-156.

Campello, M., Gao, J., Qiu, J. and Zhang, Y. (2018), "Bankruptcy and the cost of organized labor: evidence from union elections", *The Review of Financial Studies*, Vol. 31 No. 3, pp. 980-1013.

Conrad, J., Dittmar, R. and Hameed, A. (2012), "Cross-market and cross-firm effects in implied default probabilities and recovery values", *2012 American Finance Association Annual Conference, Chicago, IL, January 6-8.*

Darrat, A., Gray, S., Park, J. and Wu, Y. (2016), "Corporate governance and bankruptcy risk", *Journal of Accounting, Auditing & Finance*, Vol. 31 No. 2, pp. 163-202.

Dawkins, M.C., Bhattacharya, N. and Bamber, L.S. (2007), "Systematic share price fluctuations after bankruptcy filings and the investors who drive them", *Journal of Financial and Quantitative Analysis*, Vol. 42 No. 2, pp. 399-419.

Dichev, I.D. (1998), "Is the risk of bankruptcy a systematic risk?", *The Journal of Finance*, Vol. 53 No. 3, pp. 1131-1147.

Donovan, J., Frankel, R. and Martin, X. (2015), "Accounting conservatism and creditor recovery rate", *The Accounting Review*, Vol. 90 No. 6, pp. 2267-2303.

Eberhart, A.C., Altman, E.I. and Aggarwal, R. (1999), "The equity performance of firms emerging from bankruptcy", *The Journal of Finance*, Vol. 54 No. 5, pp. 1855-1868.

Fisher, T., Gavious, I. and Martel, J. (2019), "Earnings management in Chapter 11 bankruptcy", *Abacus*, Vol. 55 No. 2, pp. 273-305.

Franks, J. and Loranth, G. (2013), "A study of bankruptcy costs and the allocation of control", *Review of Finance*, Vol. 18 No. 3, pp. 961-997.

Franks, J.R. and Torous, W.N. (1989), "An empirical investigation of US firms in reorganization", *The Journal of Finance*, Vol. 44 No. 3, pp. 747-769.

Goyal, V.K. and Wang, W. (2013), "Debt maturity and asymmetric information: evidence from default risk changes", *Journal of Financial and Quantitative Analysis*, Vol. 48 No. 3, pp. 789-817.

Hess, D. and Huettemann, M. (2018), "Predicting bankruptcy via cross-sectional earnings forecasts", working paper.

Hillegeist, S., Keating, E., Cram, D. and Lundstedt, K. (2004), "Assessing the probability of bankruptcy", *Review of Accounting Studies*, Vol. 9 No. 1, pp. 5-34.

Ivashina, V., Iverson, B. and Smith, D. (2016), "The ownership and trading of debt claims in Chapter 11 restructurings", *Journal of Financial Economics*, Vol. 119 No. 2, pp. 316-335.

James, S. (2016), "Strategic bankruptcy: a stakeholder management perspective", *Journal of Business Research*, Vol. 69 No. 2, pp. 492-499.

Kim, Y. and Nabar, S. (2007), "Bankruptcy probability changes and the differential informativeness of bond upgrades and downgrades", *Journal of Banking & Finance*, Vol. 31 No. 12, pp. 3843-3861.

Leland, H. (2002), "Predictions of expected default frequencies in structural models of debt", *2002 Venice Conference on Credit Risk, Venice, September 8*.

Lennox, C. (1999), "The accuracy and incremental information content of audit reports in predicting bankruptcy", *Journal of Business Finance & Accounting*, Vol. 26 Nos 5-6, pp. 757-778.

Li, Y. and Zhong, Z.K. (2013), "Investing in Chapter 11 stocks: trading, value, and performance", *Journal of Financial Markets*, Vol. 16 No. 1, pp. 33-60.

LoPucki, L. and Doherty, J. (2015), "Bankruptcy survival", *UCLA Law Review*, Vol. 62 No. 4, pp. 972-1015.

LoPucki, L. and Kalin, S. (2001), "Failure of public company bankruptcies in Delaware and New York: empirical evidence of a race to the bottom", *Vanderbilt Law Review*, Vol. 54, pp. 231-282.

Michel, A., Shaked, I. and McHugh, C. (1998), "After bankruptcy: can ugly ducklings turn into swans?", *Financial Analysts Journal*, Vol. 54 No. 3, pp. 31-40.

Modigliani, F. and Miller, M. (1958), "The cost of capital, corporation finance, and the theory of investment", *American Economic Review*, Vol. 48 No. 3, pp. 261-297.

Modigliani, F. and Miller, M. (1963), "Corporate income taxes and the cost of capital: a correction", *American Economic Review*, Vol. 53 No. 3, pp. 433-443.

Ohlson, J. (1980), "Financial ratios and the probabilistic prediction of bankruptcy", *Journal of Accounting Research*, Vol. 18 No. 1, pp. 109-131.

Olsen, B. and Tamm, C. (2017), "Corporate governance changes around bankruptcy", *Managerial Finance*, Vol. 43 No. 10, pp. 1152-1169.

Papke, L.E. and Wooldridge, J. (1996), "Econometric methods for fractional response variables with an application to 401(k) plan participation", *Journal of Applied Econometrics*, Vol. 11 No. 6, pp. 619-632.

Platt, H. and Platt, M. (2002), "A re-examination of the effectiveness of the bankruptcy process", *Journal of Business Finance & Accounting*, Vol. 29 Nos 9-10, pp. 1209-1237.

Warner, J. (1977), "Bankruptcy costs: some evidence", *The Journal of Finance*, Vol. 32 No. 2, pp. 337-347.

Xia, J., Dawley, D., Jiang, H., Ma, R. and Boal, K. (2016), "Resolving the dilemma of signaling bankrupt-firm emergence: a dynamic integrative view", *Strategic Management Journal*, Vol. 37 No. 8, pp. 1754-1764.

Xu, X., Sun, Y. and Hua, Z. (2010), "Reducing the probability of bankruptcy through supply chain coordination", *IEEE Transactions on Systems, Man, and Cybernetics, Part C (Applications and Reviews)*, Vol. 40 No. 2, pp. 201-215.

Further reading

Clark, T.A. and Weinstein, M.I. (1983), "The behavior of the common stock of bankrupt firms", *The Journal of Finance*, Vol. 38 No. 2, pp. 489-504.

Merton, R. (1974), "On the pricing of corporate debt: the risk structure of interest rates", *The Journal of Finance*, Vol. 29 No. 2, pp. 449-470.

Corresponding author
Hirofumi Nishi can be contacted at: h_nishi@fhsu.edu