Predicting Bankruptcy in the WorldCom Age

How to determine when it is safe to grant credit

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Knowing how to determine the credit-worthiness of your customers may help save your business.

In 2002, 191 public companies went bankrupt.[1] If one or more of your key customers were among them, how badly would you be hurt? How do you weed them out of your accounts-receivable ledger before it's too late?

To put that number in perspective, 257 public companies, with total assets of $256 billion, filed for bankruptcy in the U.S. in 2001. This was the highest number of bankruptcy filings since 1980.[2] While the total number dropped to 191 companies filing in 2002, that was still well above the 1986-2000 average of 113.[3] Furthermore, these numbers are uncomfortably large compared to the number of filings during the last recession (125 filings in 1991 and 91 filings in 1992).[4]

It is not just the number of companies going bankrupt that is of concern; it is their size. There has been a distinct trend of larger companies filing for bankruptcy over the past several years. As one dramatic example, total assets of the firms filing for bankruptcy in 2002 were $378.8 billion, compared to $258.5 billion in 2001.[5] While bankruptcy in firms of large asset size was quite rare prior to 1966, it became more common in the 1970s.[6] Since the enactment of the current U.S. Bankruptcy Code in 1978, there have been at least 100 Chapter 11 bankruptcies of firms whose asset size exceeded $1 billion.[7] Of the 191 public companies that filed in 2002, 34 had more than $1 billion in assets.[8] Perhaps more ominously, as of this writing, of the five largest bankruptcies since 1980, three have occurred within the last 15 months.[9]

Table 1. Five Largest Bankruptcies of U.S. Public Companies since 1980

Company	Date	Assets, $ billions
WorldCom, Inc.	July 2002	104
Enron Corp.	December 2001	63
Conseco, Inc.	December 2002	61
Texaco, Inc.	December 1987	36
Financial Corp. of America	September 1988	34

(Source: BankruptcyData.com)

The bankruptcy of any company has potentially significant consequences for those who do business with it. But the consequences of a large company's bankruptcy can be especially devastating, both because it affects so many other businesses and individuals and because many of its suppliers and other business associates depend disproportionately on this one customer.

Consider the recent bankruptcy of WorldCom. As of the end of 2001, the company had contractual obligations (including capital leases) extending to 2006 and beyond that totaled just under $5 billion.[10]With WorldCom going through Chapter 11 restructuring, most of those long-term commitments probably will never lead to revenues for vendors, lessors, and landlords – who by and large had already incurred capital expenditures necessary to service WorldCom's now-defunct accounts.

In this environment, business executives and finance professionals would be well advised to refresh their knowledge of bankruptcy prediction models. Fortunately, those models have been around for a while. One of the most popular of these is the Z-score model introduced by Edward Altman in a pioneering paper in 1968.[11] This model is presented here and explained in enough detail that it can be applied.

However, even those who may sometimes feel intimidated by quantitative research and formulas can understand the basic ideas.
(See Text Box 1 at the end of this article for the formula and explanation. If you are not the one in your company who would be responsible for these concerns, you should consider passing this article along to those who are responsible for credit decisions.)

The Z-score Model

For decades, considerable accounting and finance research was directed at finding a ratio that would serve well as a predictor of bankruptcy. One of the most comprehensive early studies was conducted by William Beaver. He studied the performance of various ratios as bankruptcy predictors and concluded that the cash flow to debt ratio was the single best predictor.[12]
The critical breakthrough in bankruptcy prediction, however, came in 1968 when Edward Altman decided to abandon the search for a single best ratio and built a comprehensive, statistical model using a technique called multiple discriminant analysis (MDA).[13] MDA allows a researcher to group observations into several pre-determined categories. Needless to say, the two categories that Altman was interested in were companies that did and did not go bankrupt.
Altman selected a sample of 33 manufacturing companies that had filed for bankruptcy between 1946 and 1965 and matched them with another 33 companies selected on a stratified (by both industry and asset size) random basis. He then started with 22 ratios that seemed to be intuitively plausible as bankruptcy predictors. After every trial run, he excluded the ratio that contributed least to the explanatory power of the model. Eventually, he came up with a model that contained only five ratios. (*See the textbox for a detailed description*). When Altman added these ratios together in proportions determined by the MDA procedure, he obtained a very convenient metric that he dubbed the Z-score. If the Z-score was below the cutoff line – initially set at 2.675 – the firm was classified as bankrupt (i.e., insolvent, or headed that way) and if above the cutoff line, as non-bankrupt. This model allowed him to correctly classify 94 percent of the bankrupt firms and 97 percent of the non-bankrupt firms one year prior to the filing of bankruptcy. An attempt to predict bankruptcy earlier, i.e., two years in advance, yielded lower but still impressive accuracies of 72 percent and 94 percent, respectively.
It is important to emphasize that the original Altman model is intended for use in cases of publicly-traded manufacturing firms. However, Altman has used the same approach to develop other models: Z' for privately-held manufacturing firms and Z" for non-manufacturing firms. (*See Textbox 2 at the end of the article for the formulas for Z' and Z"*.)
After conducting three subsequent tests (86 companies that had gone bankrupt in 1969-75, 110 in 1976-95, and 120 in 1997-99), Altman recommended a lower cutoff score of 1.81 and treating Z-scores between 1.81 and 2.675 as a "gray area" or "ignorance zone." If a Z-score falls into the "ignorance zone," it means that the company in question has a chance to go bankrupt, but it is not certain that it will.[14]
Interestingly, Altman found that in 1999, 20 percent of U.S. industrial firms referenced in Compustat data tapes had Z-scores below 1.81.[15] In other words, the unusually high incidence of bankruptcy in 2001-02 was to be expected!

Why Does It Work?

At this point, an interesting question to consider is why this particular set of ratios appears to have so much predictive power. Let's take a look at each ratio separately.

X_1 (Working Capital/Total Assets)
Working capital is simply the excess of current assets over current liabilities. In accounting, assets are considered current if they are expected to be converted into cash or used within one year or one operating cycle of the company if it is longer than one year. Examples of current assets include cash, accounts receivable, and inventories. Similarly, current liabilities are obligations the firm expects to settle within one year or one operating cycle. The most typical current liabilities are short-term debt and accounts payable.

Therefore, a firm with a negative working capital is very likely to experience problems meeting its short-term obligations. (There simply aren't enough current assets to cover them.) Conversely, a firm with a significantly positive working capital rarely has problems paying its bills.

X_2 (Retained Earnings/Total Assets)
Retained earnings is the sum of past years' profits the firm did not pay back to its shareholders in dividends. Significant retained earnings mean a history of profitable operation and ability to withstand periods of losses. Low retained earnings, on the other hand, may signal that a single bad year (or even quarter) can put the company out of business.

X_3 (Earnings before Interest and Taxes/Total Assets)
This ratio indicates the firm's ability to use its assets to generate earnings before interest and taxes. We are particularly concerned about earnings before interest and taxes because failing to meet interest payments would technically put the company into default on its debt obligations. EBIT is often used as an approximate measure of cash flow generated by the firm's operations. In other words, EBIT is an estimate of the size of the cash pool available for distribution between three major groups of claimants: creditors (interest and principal), government (taxes), and shareholders (dividends).

X_4 (Market Value of Equity/Book Value of Total Liabilities)
For a while, this ratio seemed somewhat puzzling. Market value of equity (sometimes also called market capitalization) is simply the market price of one common share multiplied times the number of shares outstanding. In other words, this is the stock market's estimate of what the firm is worth. But what does market value of the firm's equity have to do with its ability to service its debt?

There are at least two ways to resolve this puzzle. First, if the firm goes bankrupt, the value of its stock falls almost to zero very quickly. Thus if a firm has significant market capitalization, it should be perceived as an indication of the market's belief in its solid financial position. Second, if a firm has significant market capitalization and begins to experience temporary financial difficulties, it could resort to issuing more common stock at relatively high prices. Although the resulting cash infusion dilutes the existing shareholders' interest, it would be beneficial to creditors because it would improve the company's chances to repay its outstanding obligations.

X_5 (Sales/Total Assets)
This ratio (commonly known as asset turnover and covered in much detail in almost any accounting and finance textbook) shows how efficiently the firm uses its assets to generate sales.

But What If the Books Are Cooked?

An interesting feature of the Z-score model is its ability to withstand certain types of accounting irregularities. Consider the recent high-profile bankruptcy of WorldCom, in which management improperly recorded billions of dollars as capital expenditures instead of as operating expenses. Such a treatment would have a twofold impact on financial statements: (1) overstating earnings, and (2) overstating assets. Overstated earnings would increase the X_3 ratio in the Z-score model, while overstated assets would actually decrease three ratios, X_1, X_2, and X_5 (all three are calculated with total assets in the denominator). Therefore the overall impact of these accounting improprieties on the company's Z-score is likely to be downward.

A Test Using WorldCom
To examine the validity of this reasoning in a limited case-study setting, we computed Z-scores for WorldCom for fiscal years ending December 31, 1999, 2000, and 2001 based on its annual 10-K reports filed with the U.S. Securities and Exchange Commission. (See Table 2.) We found that the company indeed experienced a rapid deterioration in its Z-score. Obviously, this limited test has to be taken with a grain of salt (especially given that WorldCom is not a manufacturing company), but it does show how this particular type of accounting impropriety can affect the Z-score.

Table 2. Z-score Analysis for WorldCom (accounting data prior to restatements)

Ratio	Definition	1999	2000	2001
X_1	Working capital/total assets	(0.08)	(0.08)	(0.00)
X_2	Retained earnings/total assets	(0.01)	0.03	0.04
X_3	Earnings before interest and taxes/total assets	0.08	0.08	0.02
X_4	Market value of equity/book value of total liabilities	3.58	1.13	0.54
X_5	Sales/total assets	0.39	0.40	0.34
Z	**Z-score**	**2.697**	**1.274**	**0.798**

Later Developments

As noted above, one innovative aspect of Altman's original work was its radical departure from the search for a single best ratio. Rather, he sought a simple, yet comprehensive, multivariate model. Another equally innovative and equally radical idea was to use a combination of accounting and market-based indicators to forecast bankruptcy. At the time, finance scholars often questioned the validity of accounting measures, while accounting researchers thought that observing the equity market had little to do with debt-related issues such as bankruptcy.

The significance of this synthesis was not fully understood until the advent of option pricing models. First, in 1973, in a seemingly unrelated development, Fischer Black and Myron Scholes,[16] and then Robert Merton,[17] discovered a mechanism for rational option pricing, which incidentally depended on both the price of underlying shares and the volatility of that price.[18] Then, around 1984, Oldrich Vasicek and Stephen Kealhofer proposed viewing common stock as a call option on the firm's assets with a strike price equal to the book value of the firm's liabilities.[19] This approach permits an estimate of the probability of default within a specified period of time based on both accounting (the value of liabilities) and market (the share price and volatility) data.[20] These and other related developments have led to the emergence of a new school in credit analysis and fixed-income portfolio management. The underlying mathematics of the Vasicek-Kealhofer model and other modern credit risk models [21] is sometimes quite complex, but the general idea first proposed by Altman – a comprehensive synthesis of accounting and market-based measures – remains the cornerstone of contemporary credit analysis.

Conclusion

Companies that routinely grant trade credit to their key customers should consider checking the publicly-traded customers' Z-scores on a quarterly basis. Rapid deterioration of a customer's Z-score should be a signal to consider lowering that customer's credit limits and generally reducing the company's exposure to that customer.

Larger companies with sophisticated credit departments should consider implementing a comprehensive credit risk model similar to those used by commercial banks. Prudent use of credit risk modeling will help companies avoid extreme losses related to a key customer's bankruptcy.

Textbox 1. The Z-score Model Specification

The original Altman model took the following form:

$$Z = 0.012\ X1 + 0.014\ X2 + 0.033\ X3 + 0.006\ X4 + 0.999\ X5 \quad (1)$$

where

X_1 = working capital/total assets,

X_2 = retained earnings/total assets,

X_3 = earnings before interest and taxes/total assets,

X_4 = market value of equity/book value of total liabilities, and

X_5 = sales/total assets

In the original version, all ratios were stated as percentages, except X_5, which was stated as an absolute value. For example, if EBIT/total assets ratio were 15 percent, or 0.15, X_3 would be assumed to equal 15. Eventually, a more convenient specification was proposed:

$$Z = 1.2\ X_1 + 1.4\ X_2 + 3.3\ X_3 + 0.6\ X_4 + 1.0\ X_5 \quad (2)$$

In this specification, an EBIT/total assets ratio of 15 percent would result in X_3=0.15. X_5, as was the case in the original version, is stated as an absolute value. Altman himself used this version in Altman and LaFleur (1981). In the initial 1968 study, Altman used a cutoff Z-score of 2.675. After further testing, he recommended lowering the cutoff Z score to 1.81 and treating Z-scores between 1.81 and 2.675 as a "gray area" or "ignorance zone".

In the case of publicly traded companies, the data needed to do these tests is available on the annual (form 10-K) and quarterly (form 10-Q) reports that are required to be filed with the Securities and Exchange Commission (SEC). The SEC makes those reports available online via Electronic Data Gathering and Retrieval System (EDGAR):

http://www.sec.gov/cgi-bin/browse-edgar

Textbox 2. The Z′ and Z″ Models

The Z′ model is used to predict bankruptcy of privately-held manufacturing firms and takes the following form:

$$Z' = 0.717\ X_1 + 0.847\ X_2 + 3.107\ X_3 + 0.420\ X_4 + 0.998\ X_5 \quad (3)$$

Definitions of all ratios are the same that in the original Z-score model, except X_4, which in this case means book value of equity / total liabilities. Firms with $Z' \leq 1.21$ are classified as bankrupt, $Z' > 2.90$, as non-bankrupt; the space in-between, similar to the original model, is a "gray area", where the probability of incorrect classification is high.

The Z″ model is used to predict bankruptcy of privately-held non-manufacturing firms and takes the following form:

$$Z'' = 6.56\ X_1 + 3.26\ X_2 + 6.72\ X_3 + 1.05\ X_4 \quad (4)$$

Note that asset turnover (X_5) was excluded to minimize the potential industry effect. Other ratios are defined similarly to the Z′ model. The cutoff scores are also the same as those used in the Z′ model.

In the case or privately held companies, there is no publicly available source of financial information, so you would need to request the data from the firm itself or use Dun & Bradstreet data.

[1] BankruptcyData.com (http://www.BankruptcyData.com).
[2] BankruptcyData.com.
[3] Carter Pate, “Business Chapter 11 Bankruptcies: Recent Levels and Implications for 2002,” PricewaterhouseCoopers. March 2002, p. 1.
[4] ibid.
[5] Anonymous, “Corporate Bankruptcies Set Asset Record in 2002,” *Business Wire*, January 10, 2003.
[6] E. Altman, “Predicting Financial Distress of Companies: Revisiting the Z-score and ZETA® Models,” (working paper at http://pages.stern.nyu.edu/~ealtman/Zscores.pdf) 2000.
[7] E. Altman, “Financial Ratios, Discrimination Analysis and the Prediction of Corporate Bankruptcy,”*Journal of Finance*, 23, September, 1968.
[8] BankWire, 2003.
[9] BankruptcyData.com (http://www.BankruptcyData.com/Research/15_largest.htm (link no longer accessible))
[10] WorldCom Annual Report, Form 10K, filed with the Securities and Exchange Commission, March 13, 2002. Note 8 to the consolidated financial statements, p. F-2.
[11] Altman, 1968.
[12] William Beaver, “Financial Ratios as predictors of Failures,” in *Empirical Research in Accounting*, (Supplement of Selected Studies) *Journal of Accounting Research,* January, 1967.
[13] Altman, 1968.
[14] Altman, 2000.
[15] ibid. p.18.
[16] Fischer Black and Myron Scholes , “The Pricing of Options and Corporate Liabilities,” *Journal of Political Economy*, 81, 1973.
[17] Robert Merton , “Theory of Rational Option Pricing,” *Bell Journal of Economics and Management Science*, 4, 1973.
[18] The Black and Scholes model has been in the business news a great deal recently as one possible way to value grants of stock options to employees.
[19] The proprietary Vasicek-Kealhofer model is the flagship product of San Francisco-based KMV LLC, which was co-founded by Stephen Kealhofer, Andrew McQuown, and Oldrich Vasicek in 1989 and recently acquired by Moody’s for $300 million.
[20] The interested reader is referred to Peter Crosbie, “Modeling Default Risk,” KMV, 2002, for an extensive discussion of the Vasicek-Kealhofer model.
[21] Credit Metrics by JP Morgan, Credit Risk+ by Credit Suisse First Boston, and Credit Portfolio View by McKinsey & Company, to name a few.~

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