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Financial Statement Analysis and the Prediction of Financial Distress

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Abstract

Financial statement analysis has been used to assess a company's likelihood of financial distress — the probability that it will not be able to repay its debts. Financial statement analysis was used by credit suppliers to assess the credit worthiness of its borrowers. Today, financial statement analysis is ubiquitous and involves a wide variety of ratios and a wide variety of users, including trade suppliers, banks, credit-rating agencies, investors and management, among others. Financial distress refers to the inability of a company to pay its financial obligations as they mature. Empirically, academic research in accounting and finance has focused on either bond default or bankruptcy. The basic issue is whether the probability of distress varies in a significant

manner conditional upon the magnitude of the financial statement ratios. This monograph discusses the evolution of three main streams within the financial distress prediction literature: The set of dependent and explanatory variables used, the statistical methods of estimation, and the modeling of financial distress.

Contents

For over 100 years, financial statement analysis has been used to assess a company's likelihood of financial distress — the probability that it will not be able to repay its debts. Financial statement analysis was used by credit suppliers to assess the credit worthiness of its borrowers. In many cases, there was little alternative, reliable information, other than the general reputation of the borrower. A major force for the audit of financial statements arose from the demand to help ensure more reliable financial statements. For example, major users were trade suppliers allowing companies to purchase inventory on credit until the goods could be resold. For these users, there was an emphasis on short-term ability to repay, given the focus on ability to repay over the period of inventory turnover (typically a matter of 30–60 days). In this context, the current ratio (the ratio of current assets to current liabilities) was one of the first and most prominent ratios used.[1]

Today, financial statement analysis is ubiquitous and involves a wide variety of ratios and a wide variety of users, including trade suppliers, banks, credit-rating agencies, investors and management, among others. Moreover, financial statements are only one among many sources of information about a company.

Financial distress refers to the inability of a company to pay its financial obligations as they mature. Empirically, academic research in accounting and finance has focused on either bond default or bankruptcy. The basic issue is whether the probability of distress varies in a significant manner conditional upon the magnitude of the financial statement ratios.

This monograph discusses the evolution of three main streams within the financial distress prediction literature: the set of dependent and explanatory variables used, the statistical methods of estimation, and the modeling of financial distress. The outline of the monograph is as follows: Section 1 discusses concepts of financial distress. Section 2 discusses theories regarding the use of financial ratios as predictors of financial distress. Section 3 contains a brief review of the literature. Section 4 discusses the use of market price-based models of financial

[1] Throughout the monograph, the term financial ratio will be used interchangeably with the terms accounting and financial statement-based predictors of financial distress.

distress. Section 5 develops the statistical methods for empirical estimation of the probability of financial distress. Section 6 discusses the major empirical findings with respect to prediction of financial distress. Section 7 briefly summarizes some of the more relevant literature with respect to bond ratings. Section 8 presents some suggestions for future research, and Section 9 presents concluding remarks.

1

Concepts of Financial Distress

The term "financial distress" is purposely broad and hence somewhat vague. Generally speaking, it refers to the inability to pay obligations (e.g., debt) when due. Operational definitions of financial distress have focused on two main events — bond default and bankruptcy.[1] Both events are publicly knowable and the dates when they occur are known with some precision. Both properties are important because empirical studies apply each measure of financial distress as the dependent variable in statistical models that assess the conditional probability financial distress will occur.

A term often used in this literature is insolvency. There are two concepts of insolvency. The first is consonant with financial distress and refers to the inability to pay obligations when due. The second concept defines insolvency as occurring when the assets of a company exceed its liabilities. Note that in neither case does the definition imply

[1] In many cases for large corporations, bankruptcy occurs in the form of reorganization under Chapter 11 of the federal bankruptcy statute. Financially distressed firms can restructure their debt privately rather than through formal bankruptcy. Gilson et al. (1990) find that such firms tend to have more intangible assets, more bank debt relative to other forms of debt, and have fewer lenders.

that the cash balance is zero. In fact, empirically companies that either default or declare bankruptcy typically have not let their cash balances literally fall to zero.

In defining insolvency as assets exceeding liabilities (with an implied net worth that is negative), a number of issues arise. The first is, under this concept, what is meant by assets and liabilities? Clearly, the concept does not refer to assets and liabilities as defined or measured under Generally Accepted Accounting Principles (GAAP). Many high technology firms, who have negative accounting net worth, survive for many years and are not considered to be in financial distress. The reason is that such firms have unrecognized intangible assets (such as the expected economic value flowing from its research and development activities) and are viewed as having the ability to meet their obligations when due. Clearly, the concept relates to some notion of the economic value of assets and liabilities but in some non-tautological manner that permits net worth to be negative. For example, under the limited liability of corporations, net worth can never be negative. As asset values decline, the value of liabilities decline as well so that the market value of equity cannot be negative, always retaining some value as an "option."[2] This raises issues of basis for the economic value of assets and if they are to be measured as disposal values, replacement values, or present value of cash flows, as well as the measurement of liabilities as some type of promised value or some defined alternative measure. Needless to say, these ambiguities make the concept of insolvency less useful.

Moreover, even if these definitional or measurement issues are resolved, the inability to meet obligations when due is a distinct concept from the excess of liabilities over assets. At best, this latter condition may increase the probability that a debt default will occur at some point. Certainly, if assets are measured as the present value of future net cash inflows (prior to debt repayments) and liabilities as the present value of payments due to principal and interest repayment, respectively, at some stage assets will be insufficient to meet the obligations,

[2] Of course, the market value of assets less the face value of liabilities can be negative.

although it may not occur for several years (e.g., in the case of long term debt). Also the excess of liabilities over assets can reduce the incentives of the debtor to continue paying current obligations until assets are completely dissipated. The case of home mortgages where the unpaid principal balance exceeds the market value of a home is a timely but simple example.

1.1 Why Predict Financial Distress?

At an intuitive level, it may seem self-evident that it would be important to be able to predict the probability of financial distress. Clearly, attempts to do so are in widespread use. If it is assumed that bankruptcy (default) costs are zero and the rights of stakeholders (e.g., creditors, employees, shareholders) can be costlessly renegotiated, the value of the firm may be independent of the probability of financial distress. However, even in this case, from the perspective of particular stakeholders, it can be important to assess the probability of financial distress because it will determine the payout distribution associated with their investment. Of course empirically, bankruptcy and renegotiation costs are not zero and the value of the firm may be affected by the probability of financial distress.

From another perspective, Ohlson (1980) has suggested it is not obvious that it is important to assess the probability of financial distress. Principally, Ohlson argues that it is not important to predict whether or not the company will become bankrupt but rather to assess the losses that would occur under various levels of financial distress. In other words, the relevant dependent variable is not dichotomous, but is zero over some range of outcomes and is of varying magnitudes as financial distress deepens. As discussed below, a comprehensive analysis would include a consideration of the losses conditional upon financial distress. However, predicting the probability of distress can be viewed as the first step, taken before assessing the loss distribution conditional upon financial distress. Moreover, in many cases, data on investor losses under financial distress is much more difficult, if not impossible, to obtain.

1.2 Financial Distress, Likelihood Ratios, and Loss Ratios[3]

A related question is why devote resources to an event that is relatively unlikely to occur? Beaver et al. (2010a) (BCM) report that the frequency of bankruptcy is slightly less than one per cent per year for NYSE-AMEX companies and slightly higher than one per cent per year for NASDAQ companies. Given this dichotomous event occurs for approximately one per cent of firms in a given year, 99 per cent accuracy of prediction can be attained by the naïve prediction that all firms will not fail, which is a difficult accuracy standard to beat. The assumption underlying the distress prediction literature is that the loss function for prediction errors is not symmetric. In particular, the loss associated with incorrectly predicting a company is not in financial distress is substantially greater than incorrectly predicting a company will fail when it does not. From a Bayesian perspective, the expected loss of a given action (prediction) reflects the loss function as well as the probability of financial distress. Beaver (1966) discusses in detail the prediction of financial distress from a Bayesian perspective.

1.2.1 Likelihood Ratios

The study of financial ratios as predictors of financial distress is placed in its broadest context through the discussion of likelihood ratios. Their use is essentially a Bayesian approach.[4]

The problem of predicting financial distress can be viewed as a problem in assessing the probability of financial distress (FD) conditional upon the value of a ratio (or set of ratios) — $P(\text{FD}|R)$. In arriving at estimates of the conditional probability of financial distress, the possible events are viewed as being dichotomous — either the firm will experience financial distress (FD) or it will not (NFD). Prior to looking at the financial ratios of the firm, certain prior probabilities are formed.

[3] This section is based upon a similar discussion in Beaver (1966).

[4] Given two events (e.g., financial distress-FD and an observed value of a set of ratios-R), Bayes' rules states that the conditional probability of the one event (e.g., financial distress-FD, conditional on a set of ratios-R) is equal to the joint probability of those two events two divided by the marginal probability of the second event (e.g., observing a given set of ratio values), i.e., $\Pr(\text{FD}|R) = \Pr(\text{FD} \cap R)/\Pr(R)$.

The prior probabilities — $P(\text{FD})$ and $P(\text{NFD})$ — may be based upon several factors, such as the unconditional probability of financial distress for all firms, or for firms in a given industry, or with a given asset size or quality of management. For example, using the evidence referenced above, the unconditional probability of financial distress might be assessed as 1 per cent. In a simple setting, financial distress and not financial distress are the only two events that can occur.

After the financial ratios are observed, assessments of the likelihood of financial distress and not distress are formed. The likelihood ratio is the probability that the observed numerical value of the financial ratio would appear if the firm were financially distressed — $P(R|\text{FD})$ divided by the probability that the specific value of the ratio would be observed if the firm were not distressed — $P(R|\text{NFD})$. The joint probabilities are the product of the prior probabilities times the likelihood estimates. The sum of the joint probabilities is the marginal probability — $P(R)$ — the probability that a ratio of the observed numerical value could occur.

The posterior probability is the quotient of the joint probability and the marginal probability. The sum of the posterior probabilities must be 1.00. The posterior probability is the probability of financial distress (or not distress) after the ratios are observed.

The relationships can also be expressed in terms of odds ratios rather than probabilities. For example, if the probability an event, such as financial distress, will occur is 0.01 (which implies the probability of nonoccurrence is 0.99), it can also be said that the odds are 1 to 99 that the event will occur. In fact, in many cases it is common practice to state the relationships in terms of odds rather than probabilities. The prior probabilities are replaced by the prior-odds ratio, the likelihood estimates by the likelihood-odds ratio, and the posterior probabilities by the posterior-odds ratio. The following relationship exists among the three odds ratios:

$$(\text{prior-odds ratio}) \times (\text{likelihood-odds ratio}) = (\text{posterior-odds ratio}).$$

One advantage of this formulation is that empirical estimates of likelihood ratios are unaffected by the prior probability of financial distress and therefore carry with them a degree of generality. As will be

discussed, many empirical studies form estimates of the likelihood ratios using samples of firms whose relative frequency of financial distress does not mirror that of the underlying populations (e.g., matched pair designs where an equal number of distressed and non-distressed firms are in the sample). This assumes the samples reflect financial-ratio distributions that are unbiased estimates of the financial-ratio distributions of the larger population. The numerical values of the likelihood ratios, which are derived from the financial ratios of the sample, are the unbiased estimates that would apply to the population, even though the frequency of financial distress in the sample may be vastly different from that of the entire population. Using the sample estimates, it is then straightforward to multiply the likelihood ratios by the prior odds ratios for the population to obtain a posterior odds ratio.

If the likelihood-odds ratio in favor of financial distress is greater than 1 (one), the user of the ratios, after having looked at the firm's ratios, will assess that the firm is more likely to fail. The greater is the likelihood ratio, the higher the likelihood of failure. If the likelihood ratio is less than 1, the user of the ratio will expect that the firm is less likely to fail — the lower the ratio, the stronger the evidence that the firm won't fail. A likelihood ratio of 1 implies the prior expectations of the user are unchanged after looking at the ratios — the posterior-odds ratio will be numerically equal to the prior-odds ratio. In this setting, the role of empirical evidence is to provide assessments of the likelihood ratios. The information content of the ratios can be evaluated in terms of the degree to which they change the prior expectation, as reflected in the implied likelihood ratios. As an example, assume that the likelihood ratio implied by the prediction in favor of financial distress is 10 to 1 and the prior odds ratio is 1 to 99. Then the posterior odds ratio is 10 to 99 implying approximately a 0.10 probability of financial distress.

1.2.2 Loss Ratios

The incorporation of loss ratios provides an understanding of why a relatively unlikely event, such as financial distress, has received so much attention. The loss ratio refers to the relative costs of misclassifying a firm as either in financial distress or not. That is, the loss ratio reflects

the cost of assuming the firm will not experience financial distress when it will, which we characterize in symbols as (loss|FD′), relative to the cost of assuming the firm will experience financial distress when it will not, (loss|NFD′). Under the decision criterion of minimization of expected losses, a decision-maker would predict financial distress if the prior-odds ratio times the likelihood ratio exceeds 1/loss ratio.[5] Symbolically, the decision maker would predict financial distress if

$$\mathrm{P(FD)/P(NFD)} \times \mathrm{P(R|FD)/P(R|NFD)} > (1/(\mathrm{loss}|\mathrm{FD}')/(\mathrm{loss}|\mathrm{NFD}'))$$

For reasons that will be discussed below, it is typically assumed that the loss from misclassifying a distressed firm is greater than the loss from misclassifying a firm that is not distressed. Although the loss ratio is not easily quantified, a discussion of its components suggests a probable range of values. An example of the loss ratio will be considered from the point of view of a bank's lending decision.

The primary loss in misclassifying a firm that is not financially distressed is the opportunity cost of the interest income that was lost because the loan was not granted. This opportunity cost not only includes the interest income from the first loan but also the income from subsequent loans that were not granted because the first loan was rejected. What is the opportunity cost on the first loan? If the bank has no other investment alternatives, it is the loss of the interest that would have been earned on the loan. However, this is not usually the case. At a minimum, the bank has the alternative of investing in government securities or the commercial paper of leading corporations. The opportunity cost is the interest that would have been earned minus the interest on government securities or commercial paper. If acceptable loan applications equal or exceed funds available for lending (i.e., if the alternative is loaning to another firm of comparable or lower risk at the same interest rate), the opportunity cost would be zero.

What is the opportunity cost of the income lost in future periods? If the funds would otherwise be idle in future periods and if the loan applicant applies for a renewal of his loan, the opportunity cost is the interest income that could have been earned on the loan renewals.

[5] All three ratios are stated in terms of odds in favor of financial distress.

However, if the bank has alternatives available, the opportunity cost is much smaller, possibly even zero, as indicated before.

Misclassifying a distressed firm also involves a similar analysis of opportunity costs of lost interest income. One loss is the interest that is not repaid by the failed firm. The opportunity cost is the interest that could have been earned in an alternative investment. A second cost is that at the termination of the loan, the bank does not have a customer to whom it can make future loans. Note that the second cost is symmetric to the cost of misclassifying a not distressed firm. In the first case, the bank loses future income because it did not grant the loan initially, while in the second case the firm has become financially distressed and presumably is not an acceptable candidate for future loans. In either instance, the bank must seek a new borrower for its funds: the opportunity cost is the same. Note also that the first-period loss of misclassifying a failed firm increases if alternatives exist, while the first-period loss for misclassifying a non-failed firm would decrease.

Furthermore, the opportunity cost of lost interest is a small proportion of the total loss of misclassifying a distressed firm. Usually part or all of the principal is not repaid by the failed firm. The bank often incurs substantial collection costs prior to starting formal legal action. Finally, legal fees are incurred when litigation or bankruptcy proceedings are initiated.

A discussion of the monetary factors suggests that the costs of misclassifying a distressed firm are much greater than those associated with misclassifying a firm that is not financially distressed. In a world of risk aversion, the loss ratio expressed in monetary terms can understate the loss ratio expressed in terms of the utility function of the decision-maker.

Bankers speak as if the loss ratio is very high and an example can illustrate the basis for this assumption. Assume that a bank loans to firms at an interest rate of 6 per cent and that the interest rate on government securities is 3 per cent. Assume also that when a firm fails, all of the principal is lost but no collection costs or legal fees are incurred. Assume lastly that monetary losses reflect utility losses. The loss ratio would be 34 [i.e., $(100 + 3) \div (6 - 3)$]. The numerator reflects the loss from misclassifying a financially distressed firm as not

distressed, and the denominator reflects the loss from misclassifying a non-distressed firm as distressed.

Using the principle of minimization of expected losses, the decision to reject the loan will be taken if the posterior odds ratio exceeds 1/34. Given the prior odds ratios used in the previous example is 1 to 99, the posterior odds ratio must equal or exceed 34/99 or the likelihood ratio in favor of financial distress must be 99 to 34 or approximately 2.91 or greater.

Although the assessments of the loss ratio and the maximum values of the likelihood ratio are not precise, this approach provides a helpful context within which to view the later discussion of the empirical evidence. For example, it illustrates that the decision to extend a loan cannot be made solely based on the probability of financial distress. However, an assessment of the probability of financial distress is a key input into the decision making process.

The lending decision is, of course, more complex. Until now the acts of the decision-maker have been treated as dichotomous (i.e., accept or reject the loan application). However, once a loan has been accepted, the bank must also decide how much to loan and at what interest rate. These dimensions of the decision are also sensitive to the likelihood ratio. This sensitivity is sharpened by the fact that the likelihood of financial distress is partially determined by the loan amount and the interest charge. In other words, the critical likelihood ratio of the multidimensional decision is lower than that implied by a dichotomous decision model.

In fact, there are several critical values in a multidimensional decision, with one critical value separating each possible act by the decision-maker. The highest critical value is the accept–reject (i.e., failed, not failed) value, while the lowest critical value is the point where it is no longer optimal to grant to a firm an unrestricted amount of credit at the prime rate. In this situation, it is likely that the likelihood ratios implied by the financial ratios do not exceed at least one of the critical values. The implication is that ratios typically will lead to a change in decision behavior.

This perspective raises a number of issues to be addressed by a discussion of the evidence later. (1) What is the range of values for

the likelihood ratio both above and below 1.00? (2) Does the likelihood ratio vary in some systematic manner? (3) If so, what is the form of the systematic movement (e.g., monotonic)? (4) Are all financial ratios equally useful? (5) Does the likelihood ratio exceed 1.00 to the same extent that it falls below 1.00?

As discussed earlier, the naïve strategy would be to never reject a loan application because of financial distress concerns because it minimizes misclassifications. The more comprehensive approach states that a loan officer may reject a loan even if the conditional probability of financial distress is much less than 50 per cent, if the loss function is asymmetric.

1.3 Who is Interested in Predicting Financial Distress?

Thus far, we have discussed the importance of predicting financial distress from the perspective of investors, lenders, and others who are affected by financial distress. From this perspective, these users are interested in whatever information may be of help and it may be incidental that financial statements are one candidate. However, the ability of financial statements to assess financial distress is of particular interest because it provides one context in which to assess the usefulness of financial statements — an issue of central importance to policy makers (e.g., FASB, IASB, and SEC), the practicing accounting profession and researchers. In addition, the ability to predict financial distress is also important to lenders (as illustrated earlier), bank regulators, equity investors, bond holders and participants in the credit default swap markets. As discussed later, there are also many other contexts in which to provide evidence on usefulness. Some of these (e.g., security price and contracting research) will be briefly discussed later.

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