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Two Features of Empirical Credit Models

The empirical credit models differ from reduced form and structural credit models in two important ways. First, empirical models are based on the belief that the default process is too complex to be modeled mathematically. Therefore, the focus is on using historical data on default to understand credit risk in a rather crude way. Second, empirical models do not attempt to generate an estimate of the probability of default or credit spread, at least not directly. The primary goal of empirical models is to create a credit score. A credit score is a measure that can be used to rank or assess the relative riskiness of firms or securities. The absolute values of these credit scores usually do not contain much useful information but rather are used on a relative basis to rank firms or securities in terms of their credit risk. For this reason, empirical models are sometimes referred to as credit scoring models.

The Purpose of Altman's Z-Score Model

In this section, we provide a brief overview of an important credit scoring model: Altman's Z-score (Altman 1968; Saunders and Allen 2010). First, we discuss certain characteristics of a business, to specify and quantify the variables that are effective indicators and predictors of corporate distress. Second, we discuss how a set of financial and economic ratios can be analyzed in a context of corporate distress prediction by creating a credit score for the business.

The Z-score model focuses on a set of financial ratios that are based on a firm's financial statements as well as the market value of the firm's equity to generate a Z-score which is a relative rank of the likelihood of default. The ratios focus on those characteristics of firms that have proven to be useful in predicting financial distress, taking into account liquidity, profitability, leverage, solvency, and activity of a firm. Altman, who created the Z-score in the 1960s, used a linear econometric model to determine how important each characteristic is in predicting financial distress. The following equation displays the econometric model estimated by Altman:

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

In this expression, Z is the resulting Z-score, or the credit score. The five X variables determine the credit score and are detailed in the next section.

The Five Determinants of Altman's Z-Scores

There are five variables that determine Altman's Z-scores as depicted in Equation 1:

1. X_1: *Working Capital/Total Assets*. This ratio, frequently found in studies of corporate problems, is a measure of the net liquid assets of the firm relative to its total capitalization. Working capital is defined as the difference between current assets and current liabilities. Liquidity and size characteristics are explicitly considered. Ordinarily, a firm experiencing consistent operating losses will have shrinking current assets in relation to total assets.

2. X_2: *Retained Earnings/Total Assets*. This ratio measures the relative size of the total amount of reinvested earnings and/or losses of a firm over its entire life. This is a measure of the cumulative profitability of the firm over time and is likely to be low for young firms. This ratio is indirectly related to leverage, since those firms with relatively high ratios are more likely to have financed their assets through retention of profits and not to have used as much debt.

3. X_3: *Earnings before Interest and Taxes/Total Assets*. This ratio is a measure of the true productivity of the firm's assets, independent of any tax or leverage factors. Since a firm's ultimate existence is based on the earning power of its assets, this ratio appears to be particularly appropriate for studies dealing with corporate failure. Furthermore, insolvency in a bankruptcy sense occurs when the total liabilities exceed a fair valuation of the firm's assets, with the value determined by the earning power of the assets.

4. X_4: *Market Value of Equity/Book Value of Total Liabilities*. With the knowledge that assets minus liabilities equals equity, this measure shows how much the firm's assets can decline in value before the liabilities exceed the assets and the firm becomes insolvent. For example, the value of X_4 will be equal to 2 for a firm with a market value of its equity equal to $1,000 and debt of $500, and the firm could experience a two-thirds [2/(2 + 1)] drop in asset value before insolvency. However, the same firm with $500 equity will be insolvent if assets drop by only one-half in value.

5. X_5: *Sales/Total Assets*. This ratio, which is known as the asset-turnover ratio, is a standard financial ratio illustrating the sales-generating ability of the firm's assets. It is one measure of management's capacity in dealing with competitive conditions.

Altman used these five variables and historical data on a sample of firms—of which some defaulted and some survived—to estimate the coefficients that appear in Equation 1. The goal was to find coefficients to explanatory variables that maximized the maximum predictability power of default for the firms in the sample.

Interpreting Z-Scores in Altman's Credit Scoring Model

The absolute values of Z-scores do not have intuitive interpretations; one can use them to rank firms in terms of their levels of credit risk or likelihood of default. Using historical data on the performance of firms for which the Z-scores were calculated. Altman has developed the following rule for interpreting the absolute values of these scores:

- $Z < 1.81$: Default group
- $1.81 \leq Z \leq 2.99$: Gray zone
- $Z > 2.99$: Nondefault group

The 3.61 Z-score for the sample firm (PQR Corporation) indicates that this firm belongs to the nondefault group.