Altman Z-Score Econometric Insolvency Prediction Model
For Risk Coverage In Companies

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Abstract

This study evaluates the financial strength of the company independent of its size and economic sector of the private sector with the application of the econometric model of Altman Z-score, a financial instrument derived from risk coverage, quantitative study of applied type with mathematical analysis was based on having the financial information, characterized by a medium production, debts with the banking sector, the basis of net sales and total assets, this econometric model is useful to decision making a tool that measures the solvency and behavior of the organization evaluated usually within the next two years, time to design an administrative plan to normalize the finances.

Keywords: Risk factor, Econometric model, Altman Z-score.

Introduction

Organizations seek to invest their money with the certainty of future financial gains and not obtain a bankruptcy which is called a risk factor to be faced, having a predictive model on the presence of financial insolvency through an iterative statistical analysis of multiple discrimination becomes a key factor in their decision making. A company eventually reaches a crisis point and is forced to make changes to survive in the business environment, one of these changes is the use of earnings management practices, an increase in earnings represents an increase in the value of the company and a decrease in earnings indicates a decrease in value (Valaskova et al., 2021). Altman's Z-Score model predicts insolvency by taking the financial information of a private company by performing the weighting of indicators known as the Z-score, published in the year of 1968 by Edward Altman, professor of finance.
In financial situations inconveniences are generated when the financial sector provides resources so that investors can act, including having credit risk measures, but not all situations present the same results; therefore, not all measures can have the same classification, sometimes credit risk measures are used to classify assets by default risk for the creation of portfolios or simply to establish investment priorities. If all measures gave the same ranking, even though some are known to provide worse goodness-of-fit, they could be used interchangeably; otherwise, they could not (Abinzano et al., 2020).

Applying the Z-score model with the correct information helps to predict the probability that a company may go bankrupt. Usually, within the next two years, this time is good for a management plan to be designed with which to normalize the finances, predicting the failure of a company and taking sufficient measures to prevent it are among the main concerns of analysts. This led to the development of a large body of literature on the use of balance sheet indicators and market valuations to analyze corporate financial risk (Selman, 2021). Some companies especially small and medium-sized ones rely heavily on bank loans, which puts additional pressure on the company's management to falsify financial reports (Musanovic and Halilbegovic, 2021).

As proposed by Edward Altman, the Z-score model evaluates the financial situations of private sector companies for the solvency risk they may have, because the model works as a preventive for a financial failure facilitating the application of a single equation. The main reason is that systemic risk measures generally focus on one (or a few) aspects of the vulnerability of financial institutions, while financial institutions, especially systemically important banks are often large and complex, making it difficult for a single measure to reliably assess them (Xiping et al., 2020). Insolvency risk is measured using two alternative indicators which are the Z-score and the stability of inefficiency, while profitability is measured by return on assets (Tan and Anchor, 2016).

The strength of the model lies in the five indicators that make up the equation, and the coefficients that allow finding the probability that a company can go bankrupt, in addition to being able to build an optimal portfolio where many factors are reviewed. The stock selection process is dynamic and always challenging, which becomes a prerequisite for building an optimal portfolio. To make a rational financial investment decision, an investor needs to choose investment instruments carefully from a variety of investment classes. These financial investments include stocks, bonds, mutual funds, etc. (Roy, 2016).

At first, Altman put forward a model made up of twenty-two (22) financial indicators to then perform a multiple discrimination analysis with fewer indicators to help predict financial failures. The Altman Z-score model combined five financial indices with different weights to produce a single Z-score number. The Z-score represents the overall financial health index of firms (Wu et al., 2022). Indeed, De la Vega (2016) states that:

“Allman calculated twenty-two financial ratios for the sixty-six corporations referenced, but with an emphasis on companies that later filed for bankruptcy, using financial
statements that were released one year before the bankruptcy. The objective was to select a small number of these financial ratios to be able to differentiate between a company likely to go bankrupt and a healthy company”.

With the application of the model, an analysis of the financial situation must be carried out, and this is performed on multiple discrimination because the equation posed classifies the information and identifies whether the company being analyzed presents a risk of bankruptcy, the prediction of financial difficulties was first modeled through Altman Z-score, formulated in 1968, which has been developed. Where the manufacturing sector plays a leading role in the growth of a developing economy in general and the Indian economy in particular (Sareen and Sharma, 2021). Lizarzaburu (2014) citing Ibarra (2001), confirms that:

“The aim was to refine the model and orient it to measure the risk of private companies. These studies were carried out in highly industrialized countries such as Germany, Australia, Italy, Israel, Japan and the United Kingdom. Altman would call this new method Company and Country Riskmodels”.

The z-score reflects the number of standard deviations by which returns would have to fall from the mean to wipe out bank equity. Higher z-score values are indicative of a lower probability of insolvency risk and greater stability (Keffala and Farjaoui, 2020). EBITDA, an acronym for Earnings Before Interest Taxes Depreciation and Amortization, is another indicator of the company’s situation. There are companies not able to generate enough EBITDA to meet interest and loan payments among others, this financial indicator allows to know the financial performance before taxes, amortization and depreciation, excluding a financial expense that does not involve cash outflow, however, gradually the company is losing its top line to competitors or the management is not efficient enough to keep operating costs under control (Divekar and Sukhari, 2021). There is a debate on the use of best metrics to assess financial performance at the firm level, and this study employs some new measures, such as earnings before interest, taxes, depreciation and amortization (EBITDA) and returns on investment (ROI), which help to better understand the role of IC in improving financial performance (Xu and Liu, 2021).

The model includes sales revenues, as well as the productive sector where the company is located, facilitating the evaluation of financial solvency because it limits the assets that may eventually present insolvency. Another way to consider insolvency is to limit the focus to liquid assets, assets and short-term liabilities. Insolvency occurs when the decline in liquid assets is severe enough to exceed the value of equity (Bakoush et al., 2022). Altman's model has a high accuracy proven by companies that have applied it, but care must be taken in the use of variables that make up the equation so as not to make mistakes. The arbitrary variable selection remains a significant weakness of most models. The classic Altman model, which uses several interconnected financial indicators, is the best example (Berent et al., 2017). The z-score represents the number of standard
deviations by which a bank's profitability must decline before the bank's entire equity is depleted. Therefore, the z-score is negatively related to the probability of insolvency (Smaoui et al., 2020).

Finally, the model allows financial inclusion with guarantees that allow an analysis to be made that will have confidence when making decisions because it will be known whether there is a risk of bankruptcy or not. Financial inclusion, promoted by Grameen Bank, has developed through innovative practices, such as solidarity-based collective guarantees based on trust, taking into account that management and capital guarantees are reserved (Dueñas-Peña, Palacios-Rozo and Barbosa-Guerrero, 2022). The model has accuracy with a high percentage of hits over 75% with a percentage of negatives that is around 6%; therefore, it prevents companies from performing some kind of dishonest practice to show unreal financial results, when facing financial turbulences, companies tend to employ some creative accounting practices to improve their financial performance, mainly due to the company's stakeholders (suppliers, investors, banks, employees, etc.).

Materials and methods

This analysis was based on the financial information of a textile company located in the city of Bogota in Colombia, which was characterized by medium production and having debts with the banking sector, the financial information was selected based on net sales and total assets. The financial indicators are as follows:

\[
X_1 = \frac{\text{Working Capital}}{\text{Total Assets}}
\]
\[
X_2 = \frac{\text{Retained Earnings}}{\text{Total Assets}}
\]
\[
X_3 = \frac{\text{EBITDA}}{\text{Total Assets}}
\]
\[
X_4 = \frac{\text{Book value of shareholders' equity}}{\text{Total Assets}}
\]
\[
X_5 = \frac{\text{Net Sales}}{\text{Total Assets}}
\]

To predict the bankruptcy potential, the Z-score is calculated and the company's soundness is evaluated by applying the equations of Altman's Z-score model. Taking into account that when Altman designed his model, he created it with the manufacturing industry in mind; therefore, it could not be applied to other sectors, leading him to look for a solution to this limitation, by finding two variations, which he called model Z1 and model Z2, thus making it applicable to other sectors. The model remained the same, changing the value of the factors according to the sector. The financial information allows integrating the theoretical part with the analysis of the data, so this methodology is the most appropriate to carry out the analysis of the bankruptcy.

The following values are obtained as solutions in the two new models Z1 and Z2:

\[
Z_1 = 0.717(X_1) + 0.847(X_2) + 3.107(X_3) + 0.420(X_4) + 0.998(X_5)
\]
\[
Z_2 = 6.56(X_1) + 3.26(X_2) + 6.72(X_3) + 1.05(X_4).
\]
Thus, demonstrating that the factors are adjusted to the new values and that the only difference is that the Z1 model contains a new factor X5 that does not have the Z2 model, this factor is taken into account for the management of a greater volume in production. It will be possible to reduce the limitations generated by the application of the model by having updated financial information, which will allow the financial indicators that make up this model to determine the financial situation of the company and the indebtedness in which it finds itself. The Altman Z-Score model, including its variants model Z1 and model Z2, allows the liquidity situation of the company to be identified, as well as the possible risks of bankruptcy.

In this respect, Altman (1968) states that:

“The approach to the study and early detection of operational and financial difficulties in companies was traditionally carried out with the use of conventional financial ratios; however, academics and practitioners have been moving away from ratio analysis as an analytical tool towards more rigorous statistical techniques such as multiple discriminant analysis (MDA)”

Therefore, the methodology used consisted of working with five (5) financial indicators, which are as follows:

X1= Working Capital/Total Assets  
X2= Retained Earnings/Total Assets  
X3= EBITDA/Total Assets  
X4= Book value of shareholders’ equity/Total Assets  
X5= Net Sales/Total Assets  
X5= Net Sales/Total Assets

After selecting these indicators, they were multiplied by the factors of the following equation:

\[ Z = 0.717X1 + 0.847X2 + 3.107X3 + 0.420X4 + 0.998X5 \]

Altman identified three zones, as shown in Table 1, to carry out the analysis.

Table 1. Z-score model equation values.

<table>
<thead>
<tr>
<th>Zone</th>
<th>Z-score</th>
<th>Probability of bankruptcy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safe</td>
<td>&gt;2.99</td>
<td>Low</td>
</tr>
<tr>
<td>Gray</td>
<td>&gt;=1.88 and &lt;2.99</td>
<td>Possible bankruptcy in the next two (2) years</td>
</tr>
<tr>
<td>At risk</td>
<td>&lt;1.88</td>
<td>Bankruptcy is imminent.</td>
</tr>
</tbody>
</table>

In the case of the gray zone, it is a zone of uncertainty, the company can prepare itself or try to make decisions to avoid bankruptcy.
Results and discussion

The research analyzed the financial statements where information on total assets, working capital, retained earnings, book value, net sales and earnings before interest, taxes and depreciation and amortization was taken.

Table 2. Assets of the textile company - dollar amounts.

<table>
<thead>
<tr>
<th>ASSETS</th>
<th>Year 2021</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Assets</td>
<td></td>
</tr>
<tr>
<td>Banks and cash</td>
<td>$17,500.00</td>
</tr>
<tr>
<td>Accounts receivable</td>
<td>$4,500.00</td>
</tr>
<tr>
<td>Inventories</td>
<td>$6,500.00</td>
</tr>
<tr>
<td>Total Current Assets</td>
<td>$28,500.00</td>
</tr>
<tr>
<td>Non-Current Assets</td>
<td></td>
</tr>
<tr>
<td>Land</td>
<td>$50,000.00</td>
</tr>
<tr>
<td>Buildings</td>
<td>$39,600.00</td>
</tr>
<tr>
<td>Machinery and equipment</td>
<td>$37,500.00</td>
</tr>
<tr>
<td>Vehicles</td>
<td>$6,500.00</td>
</tr>
<tr>
<td>Total Non-Current Assets</td>
<td>$133,600.00</td>
</tr>
<tr>
<td>TOTAL ACTIVOS</td>
<td>$162,100.00</td>
</tr>
</tbody>
</table>

Using the company's financial data as an example, to calculate Altman's Z-score, the following information is taken for the company as of the year 2020:

CURRENT ASSETS $28,500.00
CURRENT LIABILITIES $17,800.00
TOTAL ASSETS $55,000.00
RETAINED EARNINGS $40,000.00
EBITDA $35,000.00
STOCKHOLDERS' EQUITY $26,300.00
SALES $45,000.00

Having the above financial information, the Altman Z-score econometric model is now used:

\[ Z = 0.717X_1 + 0.847X_2 + 3.107X_3 + 0.420X_4 + 0.998X_5 \]

The following variables are found: \(X_1, X_2, X_3, X_4\) and \(X_5\)
Then:

\[ X_1 = \frac{\text{Working Capital}}{\text{Total Assets}} \]

Working capital is the resource that the company has to operate, such as the conformation of its current assets, including cash and short-term investments, the objective is that the company does not reduce it so that its operating levels are not affected.

\[ \text{Working capital} = \text{CURRENT ASSETS} - \text{CURRENT LIABILITIES} \]

\[ \text{CURRENT ASSETS} = 28,500.00 \]
\[ \text{CURRENT LIABILITIES} = 17,800.00 \]

\[ \text{Working capital} = 28,500.00 - 17,800.00 \]
\[ \text{Working capital} = 10,700.00 \]

Once this calculation has been made, the factor \( X_1 = \frac{10,700.00}{55,000.00} \) is found.

\[ X_1 = 0.19 \]

For undistributed earnings or retained earnings, are:

\[ \text{RETAINED EARNINGS} = 40,000.00 \]
\[ \text{TOTAL ASSETS} = 55,000.00 \]

\[ X_2 = \frac{40,000.00}{55,000.00} \]

\[ X_2 = 0.73 \]

EBITDA is now used, which is revenue minus expenses, excluding financial expenses (taxes, interest, depreciation and amortization of the company), and is also an indicator with which a company can be compared with another company in the same sector.

\[ X_3 = \frac{35,000.00}{55,000.00} \]

\[ X_3 = 0.64 \]

The book value is used to assign a specific monetary valuation to each of the company's elements.

\[ \text{X4} = \frac{\text{Book value of equity}}{\text{Total Assets}} \]

\[ \text{STOCKHOLDERS' EQUITY} = 26,300.00 \]
\[ \text{TOTAL ASSETS} = 55,000.00 \]

\[ X_4 = \frac{26,300.00}{55,000.00} \]

\[ X_4 = 0.48 \]
As for net sales, it does not matter if they are made in cash or on credit, or if returns are deducted, in conclusion, it is the result of your commercial activity.

X5: Net Sales/Total Assets

VENTAS $45,000.00
ACTIVOS TOTALES $55,000.00

\[ X5 = \frac{\text{VENTAS}}{\text{ACTIVOS TOTALES}} = \frac{45,000.00}{55,000.00} = 0.82 \]

Since all the indicators have already been calculated, the values are now substituted into the model:

\[ Z = 0.717X_1 + 0.847X_2 + 3.107X_3 + 0.420X_4 + 0.998X_5 \]

\[ Z = 0.717(0.19) + 0.847(0.73) + 3.107(0.64) + 0.420(0.48) + 0.998(0.82) \]

\[ Z = 3.8 \]

The interpretation of the value obtained is made by taking into account the values in Table 1, where it can be seen that the textile company is in a safe zone by obtaining a value of Z greater than 2.99, therefore the probability of bankruptcy is low.

**Conclusions**

A model is an efficient tool that allows obtaining reliable data and results as well as financial indicators with a high probability of accuracy for decision making, obtaining the company's financial control and avoiding problems that lead to the bankruptcy of the organization.

The calculations obtained for decision-making manages to avoid financial bankruptcy where the company with these tools can evaluate to make decisions, being able to have information in advance about what will happen to the company will allow in case you are going to invest to stop that decision making and to analyze other companies where the investment will finally be made, this is a reallocation of capital.

Being able to avoid a financial bankruptcy will eventually allow wealth to be generated, thus allowing to establish the company and review the opportunities and threats that could have led it to this situation, therefore the importance of the model analyzed in the work and composed of financial indicators result in greater effectiveness proven for decades in a company achieving a success rate greater than eighty percent, it also takes into account the behavior of the sector to which the company belongs that is being evaluated because the results obtained will allow the financial strengthening of the same.

The company facing uncertainty has the Altman Z-Score model with which they can have valuable information on the probability of bankruptcy, which allows in case of obtaining a gray area to have
a considerable time to make decisions to avoid bankruptcy, so it is important to carry out a good analysis of the financial data this facilitates the correct calculation of financial indicators.

References


