A Comprehensive Review of the Altman Z-Score Model Across Industries

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Abstract

This study explores the Altman Z-Score model in depth, investigating its evolution and diverse range of applications. Starting from its inception, the study highlights the modifications made by Altman to the model over time. The study examines the utilization of the Altman Z-Score in various sectors, including both public and private enterprises, as well as its tailored application for emerging markets. Each version of the model is thoroughly analyzed, providing a clear understanding of its elements and explanations in the assessment of financial stability. The Altman Z-Score model separates itself by offering a comprehensive analysis of a company's financial well-being beyond traditional ratios. By categorizing enterprises into safe, gray, and distress zones, the Altman Z-Score provides valuable insights for financial decision-makers.The article highlights the enduring significance and adaptability of the model across different economic scenarios, making it a valuable tool for investors,analysts, and other stakeholderswho are interested in assessing a firm's financial health.

Keywords: *Altman Z-score, Financial Distress, Bankruptcy, Multiple Discriminant Analysis*

Introduction

Financial health is a primary financial health is a primary concern in the ever-evolving landscape of global business. Investors, creditors, and financial analysts are constantly looking for reliable techniques to assess the health and resilience of businesses across a wide range of industries. One such essential instrument that has endured the test of time is the Altman Z-Score model, suggested by Altman (1968).The Altman Z score is the most extensively used measure for assessing financial distress. The model examines a company's financial stability by examining its financial statements and ratios. The model considers parameters such as profitability, leverage, liquidity, solvency, and activity. The model is comprised of five financial ratios, each indicating a specific aspect of a firm's financial health. This article will explore the complexities of these components, shedding light on how working capital, retained earnings, earnings before interest and taxes (EBIT), market value of equity, and sales are interconnected to provide a comprehensive assessment. Edward Altman's pioneering research in financial analysis has created the framework for a metric that goes beyond mere profitability or liquidity evaluations. The Altman Z-Score, which evolves over time, provides a comprehensive view of a company's financial health, providing insights into its likelihood of bankruptcy and overall stability. Edward Altman's contribution to refining and improving the

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Z-Score model has developed a tool that has become a standard in financial research. From its origin to the current modifications, the model has adapted to the shifting dynamics of the business environment.

The Altman Z-Score model serves as a valuable tool for assessing and predicting financial health across various economic landscapes, including public enterprises, private enterprises, and emerging economies. Public enterprises, which often operate under distinct regulatory frameworks, derive benefit from the Altman Z-Score as it provides a comprehensive evaluation of their financial stability.

By examining key financial ratios, the model aids in assessing the risk of bankruptcy or financial distress, thereby assisting public entities in making well-informed decisions regarding resource allocation and financial management. In the private sector, where competition and market forces determine the landscape, the Altman Z-Score goes through a tailored adaptation. Recognizing the limitations of the initial model for publicly traded corporations, Edward Altman called for a re-estimation to include privately held businesses. Moreover, considering the rise of emerging economies in the global economic scenario, the Altman Z-Score model gains unique importance. These emerging markets, characterized by rapid growth and distinctive financial structures, require a specialized perspective for risk assessment. Altman identified this need and adjusted the model, introducing modifications to accommodate the peculiarities of emerging economies.

This paper aims to examine the evolution of the Altman Z-Score model, providing a comprehensive understanding of its key modifications that have significantly improved its accuracy and relevance. In addition, we will explore the interpretation of Z-Score results, clarify the zones of safety, gray, and distress, and also investigate the applications of the Altman Z-Score model in different sectors.

The Evolution of Altman Z Score

Altman's vision entailed a comprehensive evaluation that goes beyond individual financial ratios, integrating a combination of key elements to generate the Z-Score, a metric that provides a comprehensive perspective on a company's financial well-being. The model was initially introduced by Altman in 1968 with the primary aim of forecasting corporate insolvency using a combination of financial ratios. Over the years, Altman refined and improved the Z-Score model by incorporating new insights and adjusting the formula to enhance its accuracy and applicability. The introduction of sector-specific Z-Scores and adjustments for emerging economies are two significant advancements in the model's progress.

Altman Z score model for public enterprises

Altman (1968) assembled a collection of 22 financial ratios to be evaluated through the examination of financial statements. These ratios were methodically categorized into five standard groups: profitability, liquidity, solvency,leverage, and activity. The selection of these ratios was based on their widespread usage in existing literature and their perceived significance within the study's context. The final discriminant function of Altman, as presented in his influential research, is outlined below:

$$Z\ Value = \{(0.012\times X1)+(0.014\times X2) + (0.033\times X3) + (0.006\times X4) + (0.999\times X5)\}$$

or

$$Z\ Value= \{(1.2\times X1) + (1.4\times X2) + (3.3\times X3) + (0.6\times X4) + (1.0\times X5)\}$$ (Altman et al., 2014)

Whereas,

Z represents theoverall indicator.

X1 represents the ratio of a firm's net working capital to its total value of assets.

X2 represents the ratio of the firm's retained profits to its total value of assets.

X3 represents the ratio of a firm's earnings before interest and taxes (EBIT) to its total assets.

X4 represents the ratio of a firm's market value of equity to its book value of total liabilities.

X5 represents the ratio of a firm's total sales to its total value ofassets.

The ratio designated as X1 represents the comparison between the net working capital and the aggregate assets of a firm. Net working capital is ascertained by deducting current liabilities from current assets. This ratio assumes a pivotal role in evaluating a firm's capacity to fulfill its immediate financial obligations. In situations where a firm regularly encounters operational losses, the proportion of current assets to total assets tends to decrease. Unlike the current ratio or the quick ratio, which are commonly used liquidity ratios, Altman argues that the working capital to total assets ratio is more advantageous (Altman, 2000; Chuvakhin and Germania, 2003). A higher ratio indicates an increased capacity for the firm to effectively manage short-term financial difficulties.

The proportion of retained earnings to total assets, indicated by X2, acts as a vital indicator for evaluating a firm's financial health over an extended period of time. This specific ratio provides insights into the extent to which a firm has utilized its retained earnings to strengthen its asset base rather than relying heavily on debt financing. A higher value of this ratio indicates a strong financial standing, characterized by a reduced dependency on external debt. Conversely, a lower ratio of retained earnings may imply diminished longevity for the firm. According to Dun and Bradstreet, a reputable provider of business information, a considerable number of firms encounter failure within the initial five years of their establishment (Altman, 2000).

The X3 ratio, which evaluates the proportion of earnings before interest and taxes (EBIT) to total assets, offers a valuable indicator of a firm's profitability in relation to its overall asset base. Essentially, it assesses how effectively a firm's assets are utilized to generate operating income. Altman (2000) categorizes it as a superior measure of profitability compared to cash flow. A higher X3 ratio indicates that the firm is generating a significant operating income per unit of total assets, exhibiting operational effectiveness. Examining this ratio over time provides valuable insights into a company's ability to effectively utilize its asset base for profitability, making it a key metric in evaluating the financial health and efficiency of the company.

The X4 ratio, which represents the ratio of the market value of equity to the book value of total liabilities, offers a distinct perspective on the financial health of a firm. It illustrates the extent to which the company's assets may undergo a decrease in value (as calculated by the market value of equity plus debt) before liabilities surpass assets, ultimately leading to insolvency. This ratio introduces a market value dimension to the model, thereby providing insights into the potential for financial distress. Moreover, it serves as a pivotal indicator of a firm's long-term financial stability. A higher X4 ratio not only signifies investor confidence but also signifies a reduced risk of bankruptcy. According to Altman (1968), this ratio emerges as a more effective predictor of financial distress compared to ratios such as net worth/total debt based on book values. By focusing on the relationship between market value, equity, and total liabilities, the X4 ratio offers valuable insights into a firm's overall financial soundness in the

long run. Consistently monitoring this ratio presents a proactive approach to evaluating the risk of financial instability and bankruptcy for the institution.

The X5 ratio, which represents the ratio of sales to the book value of total assets and is a widely used indicator to measure capital turnover, acts as a significant indicator of a company's capacity to generate sales by making efficient use of its assets. This particular ratio provides valuable insights into the ability of management to effectively navigate competitive conditions. Specifically, it demonstrates how proficiently a firm utilizes its assets to generate revenue, thereby offering valuable information regarding operational efficiency. This ratio serves as an indicator of a company's effective use of assets to generate sales (Chuvakhin & Gertmenian, 2003). The sales-to-total-assets ratio remains a crucial measure of a company's operational excellence and its ability to convert assets into revenue efficiently. By monitoring this ratio, one can gain a comprehensive understanding of a company's competitive strength and its efficiency in utilizing capital. However, it is worth noting that in the subsequent development of the Z-Score model, this ratio was excluded from the Z-Score model.

Interpretation of the Z score model for public enterprises (Eidleman-1995;Rance-1999; Anjum-2012)

Z Score	Indicator	Remarks
"Z >2.67"	"Safe Zone"	The firm has good financial stability, and there is minimal chance that it will go bankrupt.
"1.81<Z<2.67"	"Gray Zone"	The risk of the firm facing financial difficulties in the near future is low.
"Z<1.81"	"Distress Zone"	The firm is likely to experience financial challenges in the near future.

Altman Z score model for Private enterprises

In response to the limitation inherent in the original Z-Score Model, which was restricted in its applicability to publicly traded companies due to its reliance on market value, Altman (1983) proposed a substantial revision. This involved undertaking a comprehensive re-estimation of the model by substituting the market value with the book value of equity in X4, while also making adjustments to weights and cut-off scores. Through this modification, Altman formulated the revised Z'-Score Model, which aimed to ensure a wider scope of applicability. The modified model is expressed in the following manner:

Z value = {(0.717×X1) + (0.847× X2) + (3.107× X3) + (0.420× X4) + (0 .998× X5)}

Z represents the overall indicator.

X1 represents the ratio of a firm's net working capital to its total value of assets.

X2 represents the ratio of the firm's retained profits to its total value of assets.

X3 represents the ratio of a firm's earnings before interest and taxes (EBIT) to its total assets.

X4 represents the ratio of the firm's book value of equity to the book value of its total liabilities.

X5 represents the ratio of a firm's total sales to its total value ofassets.

Interpretation of the Z score model for private enterprises (Rance, 1999; Anjum, 2012)

Z Score	Indicator	*Remarks*
"Z>2.9"	"Safe Zone"	The firm has good financial stability, and there is minimal chance that it will go bankrupt.
"1.23 <Z<2.9"	"Gray Zone"	The risk of the firm facing financial difficulties in the near future is low.
"Z<1.23"	"Distress Zone"	The firm is likely to experience financial challenges in the near future.

Altman faced constraints when evaluating the ZScore model on a secondary sample due to the absence of a comprehensive private firm database. In spite of this constraint, he carried out an analysis that emphasized the accuracy of a four-variable Z score model. This modified model removed the ratio of sales to total assets (X5) from the original Z score model. He found that variables sensitive to industry conditions, such as asset turnover, could introduce biases. Altman aimed to minimize the influence of these effects. As a result, he formulated the subsequent four-variable Z score model (Altman 1983).

Z value = {(6.56× X1) + (3.26× X2) + (6.72× X3) + (1.05× X4)}

Interpretation of the Revised Z Score Model (Rance, 1999; Anjum, 2012)

Z Score	Indicator	Remarks
"Z >2.6"	"Safe Zone"	The firm has good financial stability, and there is minimal chance that it will go bankrupt.
"1.10 <Z<2.6"	"Gray Zone'	The risk of the firm facing financial difficulties in the near future is low.
"Z<1.10"	"Distress Zone"	The firm is likely to experience financial challenges in the near future.

Altman Z score model for Emerging economies

Altman acknowledged the distinct requirements of developing economies and took proactive steps to refine the Z-Score model by incorporating a constant term into its equation. However, it became evident that the current version of the model did not fully address the specific requirements of emerging markets. In light of this realization, Altman made further adjustments to the model equation by incorporating an additional constant of 3.25. This strategic modification aimed to enhance the model's effectiveness within the context of emerging economies. Altman maintained the previously established set of cutoff limits and weights, which served as crucial benchmarks for categorizing firms into distinct solvency zones. The emerging market model is shown below:

Z value = {3.25 + (6.56×X1) + (3.26×X2) + (6.72×X3) + (1.05×X4)}.

Interpretation of the Z score model for Emerging Economies (Altman et al., 2017)

Z Score	*Indicator*	*Remarks*
"Z>2.60"	"Safe Zone"	The firm has good financial stability, and there is minimal chance that it will go bankrupt.

"1.10<Z<2.60"	"Gray Zone"	The risk of the firm facing financial difficulties in the near future is low.
"Z<1.10"	"Distress Zone"	The firm is likely to experience financial challenges in the near future.

Applications of the Altman Z score model

The Altman Z score emerges as a widely employed framework for evaluating financial distress across various industries. Chaitanya (2005) employed the Altman Z Score Model to appraise the financial distress of the Industrial Development Bank of India (IDBI), revealing inadequate financial performance and suggesting a potential danger of insolvency. Validating its effectiveness, Chung et al. (2008) ascertained that the Altman model surpassed other measures of financial distress when forecasting bankruptcy one year in advance. Broadening its applicability, Chotalia (2012) utilized Altman's Z score model to assess the financial well-being of private sector banks in India. Furthermore, Chatterjee (2018) confirmed the superior accuracy of the Altman model in evaluating the financial well-being and stability of companies.Joshi (2020) evaluated the financial well-being of selected public sector banks in India by utilizing their financial ratios. The research concluded that the Altman Z score model functions as an effective indicator for assessing the financial turmoil of public-sector banks in India. Prasad and Singh (2021) conducted an empirical investigation on Indian commercial banks, employing Altman's Z score model. The findings suggested that, especially in developing economies, the emerging market Z score proves to be a reliable approach for estimating financial distress in the banking sector.Srinivas (2023) assessed the financial distress of selected NIFTY 50 companies by using the Altman Z score model. He found that among the thirty-nine selected companies, nine are in a phase of bankruptcy. Rashid et al. (2021) employed the emerging Altman Z Score model in their study to assess the financial distress of Indian banks while also performing a comparative analysis between scheduled private sector and scheduled public sector banks at the same time.The Z value has been utilized in multiple research studies to assess financial distress, as evidenced by Boyd and Runkle (1993), Laeven and Levine (2009), Demirguc-Kunt and Huizinga (2010), Houston et al. (2010), and Beltratti and Stulz (2012). The combined findings of these studies confirm that the Z value serves as an appropriate measure for evaluating the performance of an enterprise. Significantly, it proves to be effective in identifying firms that are vulnerable to financial distress and outperforms other commonly used financial ratios as a more reliable indicator of financial instability.

Conclusion

The Altman Z-score model has been extensively studied for the past four decades and has proven to be a highly effective tool for measuring financial distress. Its application extends to various sectors, such as the service industry, manufacturing, publicly traded companies, and financial institutions, where it has demonstrated immense value in predicting bankruptcy scenarios. The three revisions of the Altman equation are commonly utilized in diverse research studies, showcasing consistent and constructive predictive capabilities. It can be confidently asserted that Altman's Z-score model remains relevant in the contemporary economy, offering the ability to foresee distress and bankruptcy.As a result, the Altman Z-score model can be auseful tool for investors, regulators, and other stakeholders who are interested in assessing a company's financial situation.

Contributions and implications

This paper contributes to our understanding of the evolution of the Altman Z-Score model over time and its utilization in various sectors. It provides a clear depiction of how the model has been tailored for public companies, private companies, and regions facing unique

economic challenges. By analyzing the historical development and modifications implemented by Altman, this paper provides a clear presentation of how the model has adapted to different financial circumstances. The study emphasizes the practical uses and flexibility of the Z-Score model, making it a valuable instrument for investors, analysts, banking institutions, policymakers, and other stakeholders. In summary, the research paper highlights the efficacy of the Z-Score model in predicting financial stability across different economic contexts.

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