

Predicting financial failure of non-life insurance companies in Turkey using the Altman Z-score model

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Abstract

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Insurance companies operate with the aim of generating profit, growing, and establishing trust in the sector in order to sustain their existence. Achieving these goals depends on companies having a sustainable and sound financial structure. Insurance companies with weaknesses or fragility in their financial structure, or those showing signs of such weaknesses, are more likely to experience financial failure, which in some cases can lead to bankruptcy. Therefore, identifying potential negative factors that could lead to financial failure at an early stage and taking necessary measures in a timely manner is crucial for reducing or completely eliminating the risk of failure. In this context, regular financial analysis and measurements that contribute to the current and future decision-making processes of insurance companies must be performed periodically. This study attempts to predict the financial success of non-life insurance companies operating in Turkey. The research focuses on financial failure prediction models and uses ten years of financial data covering the period 2014–2023. The Altman Z-Score model was applied by calculating the companies' annual financial ratios, thereby assessing each company's probability of financial failure. According to the findings, among the companies analyzed, only one company was financially successful throughout the entire period, two companies showed financial success for five years, while twelve companies failed to achieve financial success in any year during the ten-year period examined. This situation indicates that these companies are at risk of bankruptcy and that uncertainty prevails across the sector. For companies whose financial success status was determined to be uncertain, it is considered useful to conduct additional analyses using alternative financial failure prediction models (e.g., logit, probit, or machine learning-based approaches) to evaluate the current findings in greater depth.

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1. Introduction

People have always sought to develop systems that can provide security against the uncertainties and risks inherent in life [7]. Societies' perception of risk and cultural structure have played a decisive role in shaping these systems; over time, this process has paved the way for the emergence of the insurance system as it is practiced today in its modern sense. The insurance system is an important component of the financial sector due to its capacity to generate funds. In addition to contributing to economic growth, it also contributes significantly to the development of a culture of solidarity and mutual aid in society [18]. The insurance system, which can be defined as a pool mechanism where individuals or organizations obtain coverage against risks by paying a certain premium, can also be considered a risk transfer and risk management tool [13]. The establishment,

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execution, and supervision of insurance activities are carried out within the framework of legal regulations determined by the state. In Turkey, insurance companies are established as joint-stock companies or cooperatives and begin their insurance activities after completing the necessary licensing processes. These companies assume certain risks under the insurance contracts they issue and are responsible for fulfilling their obligations to cover any damages arising from these risks. Insurance is considered a system based on trust. Therefore, the competitiveness and sustainability of insurance companies in the sector are directly related to the soundness of their financial structure. Consequently, it is of great importance for companies to use all their resources effectively and efficiently. Otherwise, inefficient use of resources can lead to negative consequences, ranging from financial difficulties to even bankruptcy [3]. A decrease in a company's cash inflows can cause liquidity problems, making it difficult to meet short- and long-term obligations on time and in full. In this case, the business faces the risk of financial failure. Financial failure can be defined as the company's current cash flows or assets being insufficient to cover its debts. In contrast, bankruptcy is a legal process that arises when the company's total debts exceed its assets and this situation is certified by a court decision. In other words, bankruptcy is the legally defined and formalized form of failure to meet financial obligations. The financial failure or bankruptcy of insurance companies has the potential to create chain reactions not only in the insurance sector but also in the general economy, among policyholders, and all stakeholders involved in the sector [19]. Therefore, it is crucial to take comprehensive measures to strengthen risk management, internal audit, and capital adequacy mechanisms in order to reduce the likelihood of insurance companies being exposed to similar financial risks and to prevent potential crises. As of 2023, a total of 72 insurance companies operate in the insurance sector in Turkey. Fifty of these companies operate in non-life insurance, 15 in pensions, 3 exclusively in life insurance, and 4 in reinsurance. By the end of 2023, the total assets of insurance companies reached TRY 1.471 trillion; the share of the insurance and private pension sectors in the financial system was 5.3%. During the same period, total premium production reached TRY 1.427 trillion, while premium production in the non-life branch alone reached TRY 507 billion [23]. According to the Swiss Re Institute's (2022) World Insurance Report, while the ratio of total premium production, defined as insurance penetration, to gross domestic product (GDP) was 7% worldwide in 2021, this ratio was only 1.3% in Turkey. The same report states that the annual premium per capita was \$874 worldwide and \$124 in Turkey. Considering these indicators, Turkey ranks 68th in terms of premium production per capita [18–29]. Global insurance sector data show that approximately 80% of total insurance premium production in the 2004–2023 period belonged to OECD member countries [10]. In this context, Turkey's share in the global insurance market rose from 0.11% in 2003 to 0.24% in 2022. The amount of direct premium production in the insurance sector worldwide for the period 1980–2022 is presented in Figure 1 in five-year periods.

Figure 1 show that there has been a significant increase in the amount of direct premium production in the global insurance sector over the years. While total direct premium production was \$497.987 billion in 1980, this figure increased approximately 13.61 times to reach \$6.782 trillion in 2022. Total premium production, which stood at US\$2.760 trillion in 2000, increased approximately 2.46 times in 2022. Non-life insurance premium production also showed a remarkable increase during the same period. Non-life direct premium production, which was 1.169 trillion US dollars in 2000, rose to 3.969 trillion US dollars as of 2022. While life insurance premium production was higher than non-life insurance premiums in 2000, the non-life insurance sector has come to the fore with a faster growth rate since 2015. According to Swiss Re Institute (2023) data, total premium

production in the life and nonlife sectors worldwide reached US\$7.2 trillion. During this period, the real growth rate was 1.3% in the life sector and 3.9% in the non-life sector. When evaluated on a regional basis, the highest growth in life insurance premium production was recorded in the Asia-Pacific region, while the highest growth in non-life insurance premiums was recorded in the Americas. Direct premium production amounts for the global insurance sector for the period 1980–2022 are presented in five-year periods in Figure 2. Similarly, premium production amounts for the insurance sector in Turkey for the period 2014–2023 are presented in five year periods in Table 1 and Figure 2.

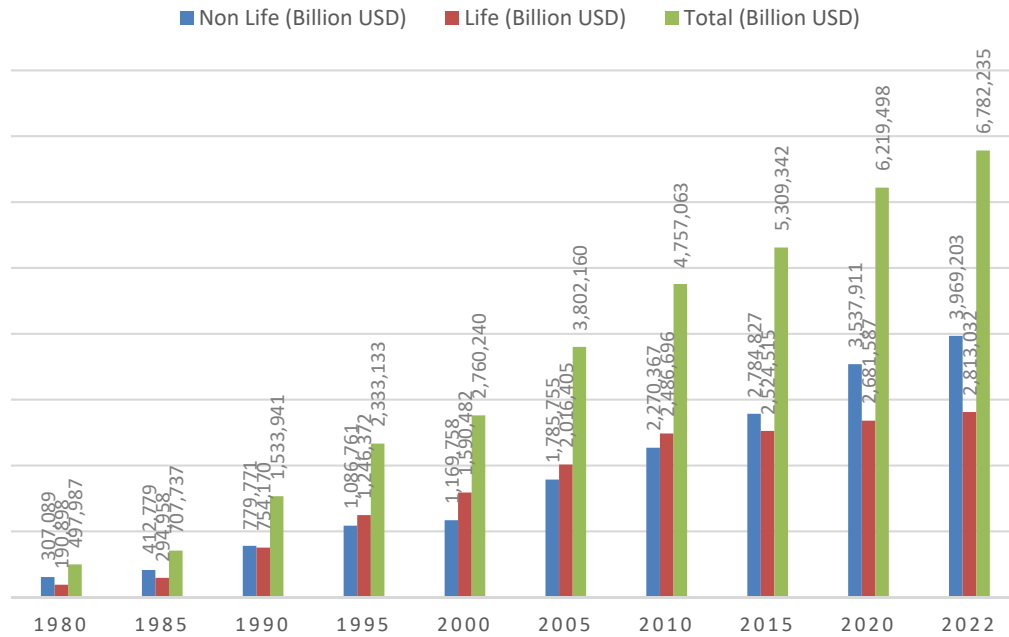


Figure 1. Direct premium production worldwide (billions of \$) (1980-2022) [8]

When the SEDDK Activity Report data and the indicators presented in Table 2 are evaluated together, a significant upward trend in the share of non-life insurance branches in the Turkish insurance sector has been observed in recent years. The non-life insurance branch, which had an 81.96% share of total premium production in 2004, increased by approximately 7.7% to reach 88.26% in 2023. These data reveal that awareness and confidence in non-life insurance products are gradually increasing in society. The increasing share indicates that both individuals and institutions have developed risk management awareness, and therefore participation in the insurance system has evolved into a stronger structure.

Table 1. Premium production amounts of the insurance sector in Türkiye [17]

Premium Production	2014	2018	2023
Non-Life (TL)	14.978.744.186	47.742.569.680	426.020.334.846
Life (TL)	3.395.325.062	6.920.646.675	56.648.419.662
Total	18.374.069.248	54.663.221.655	482.668.754.508
HD/Total(%)	81,52	87,34	88,26

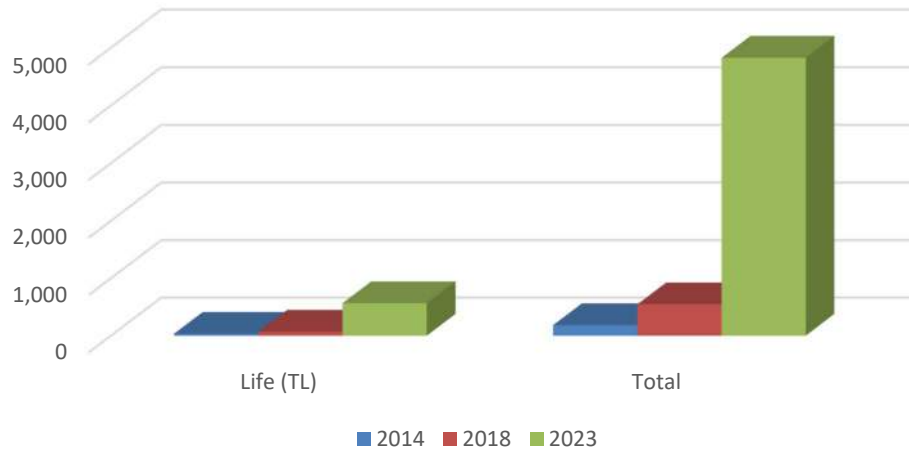


Figure 2. Insurance premium production pmounts in our country [17]

When examining global insurance market data, it is seen that Turkey's share in total insurance premium production decreased from 0.248% in 2014 to 0.239% in 2022. This situation shows that, despite our country's high insurance potential, its share in the global insurance market remained relatively stagnant during the period under review. This study aims to predict the probability of financial failure of non-life insurance companies operating in Turkey. To this end, the Altman Z-Score model, one of the most widely used financial early warning models in the literature, was used. In applying the model, various financial ratios commonly used in the insurance sector were calculated using Microsoft Excel 2016, and a data set was created for use in the analyses. The concept of financial failure began to appear in the literature in the 1960s; its importance for businesses has increased, particularly since the oil crisis of the 1970s. Different statistical models and empirical formulas have been developed to enable businesses to anticipate potential risks before experiencing financial collapse. Today, artificial intelligence-based methods are also widely used in these forecasting processes. Literature reviews show that statistical models are frequently preferred for predicting financial failure. These models are classified as univariate or multivariate statistical models, depending on the number of independent variables used in the model. Financial failure modeling provides managers with early warning information due to its potential to identify the risk of bankruptcy in advance. Indeed, research shows that such models provide effective and reliable results to businesses, making it possible to reduce or completely prevent the effects of potential failures [6]. In this context, while there are many financial prediction models developed in the literature, the Altman Z-Score model, one of the most widely used methods, has been chosen as the primary analytical tool in this study.

The study consists of four main sections. The first section explains the subject, purpose, and scope of the research; the second section covers previous studies on financial failure prediction. The third section details the research method and the analysis process applied; the fourth and final section discusses the findings and presents conclusions and recommendations.

2. Literature Review

A review of the literature reveals that the Altman Z-Score model is frequently used to measure the financial soundness and performance levels of businesses. This model is considered one of the most common statistical tools that enables the early identification of financial failure risk. However, although the model's scope of application has expanded in recent years, it is noteworthy that its application to the insurance sector remains relatively

limited. Specifically, the complex and multi-component nature of insurance companies' financial structures has resulted in fewer studies in this area compared to other sectors. Based on this situation, the present study aims to contribute to this gap in the literature by examining the applicability of the Altman Z-Score model specifically to the insurance sector and to provide a comparative basis for future research.

The Altman Z-Score model is considered an advantageous method for measuring financial soundness and bankruptcy risk because it allows meaningful results to be obtained through simple calculations using accounting-based financial data. Thanks to this feature, the model is more widely used than other statistical methods in evaluating the financial structure of businesses, particularly in the banking sector [1-11-15]. However, the unique risk structure of the insurance sector and differences in accounting practices have led to the limited use of the Altman Z-Score model in financial analyses in this field. The model is considered a tool with limited validity for this sector because it cannot comprehensively cover the risk factors specific to the operational structure of insurance companies [16].

Altman developed the Z-Score model using multivariate discriminant analysis based on the financial data of 66 companies (33 successful and 33 unsuccessful) operating in the manufacturing sector between 1946 and 1965. His study revealed that bankruptcy could be predicted two years in advance and that the model could correctly classify future failures at a 95% rate one year before bankruptcy. However, it was also emphasized that the model's predictive power decreased as the period preceding failure lengthened. The Altman working model has laid the foundation for its widespread use today due to both its ease of application and high predictive accuracy [5].

Gülençer and Hazar (2020) applied the Altman Z-Score model to test the financial failure and bankruptcy risks of companies traded on the Istanbul Stock Exchange (BIST). In the study, which analyzed the financial data of 19 companies for 2019, it was concluded that only the Index company was in the risky zone, while the other companies did not carry a risk of bankruptcy [9].

İşseveroğlu (2005) developed an original model to measure the financial success of insurance companies and predict the probability of failure. The study used data from 45 insurance companies and formed two hypotheses based on one dependent and seventeen independent variables. Comparing multiple discriminant analysis and multiple regression analysis methods, the study concluded that the developed model accurately reflected the actual situation and met the analysis requirements [12].

Kendirli and Çıtak (2022) assessed the bankruptcy risks of companies in the paper and forest products sector traded on BIST using the Altman Z-Score model; the analysis determined that 7 out of 15 companies were at risk of bankruptcy [14].

Moreno et al. [2022] examined 1,382 observations from 183 insurance companies operating in Spain between 2010 and 2017, aiming to determine the most appropriate Z-Score calculation approach for insurance companies. The study concluded that the indicator obtained by dividing the sum of return on assets and the ratio of equity to assets by the standard deviation of return on assets is the most appropriate performance measure for insurance companies [16].

Pavić Kramarić et al. (2019) analyzed the determinants of financial soundness of insurance companies in Croatia, Hungary, and Poland (2013–2017) using the Altman Z-Score model. The findings showed that company size in Croatia and reinsurance practices in Hungary and Poland had positive effects on the financial soundness of insurance companies [20].

Puławska (2021) examined the effects of the COVID-19 pandemic on the financial performance of insurance companies operating in Europe. The study used return on assets, Z-Score values, and the capital adequacy ratio calculated according to the Solvency II Directive as dependent variables. The findings revealed that the pandemic negatively affected the overall functioning of the European insurance sector, but there was no statistically significant effect on Z-Score values [21].

Yıldız and Gürkan (2022) analyzed the bankruptcy risks of companies in the tourism sector using the Altman Z, Springate, and Fulmer models. The study determined that the results regarding bankruptcy risk varied depending on the different models used [26].

Yi (2012) analyzed the financial risk and uncertainty levels of real estate companies operating in China and concluded that the accuracy rate of the Altman Z-Score model remained below 90%. The researcher emphasized that due to the structural differences between the Chinese stock market and American markets, the model did not yield accurate results during global crises and that alternative bankruptcy prediction models should be developed in this context [27].

A review of the literature revealed that the Altman Z-Score model, commonly used to predict financial failure, is effectively applied in various sectors, particularly banking, manufacturing, tourism, and real estate. However, the number of studies on the insurance sector is quite limited. The risk structure of insurance activities, capital adequacy, reinsurance ratio, and technical reserves, which are specific financial dynamics of the sector, have made it difficult to adapt the model to this field. This situation reveals a significant research gap in the form of a lack of empirical studies testing the applicability of the Altman Z-Score model in the insurance sector.

Furthermore, most studies in the literature focus on a single country, and there are very few international studies comparing the impact of economic conditions and accounting systems in different countries on the model's predictive performance. In this context, a comprehensive analysis using data specific to the Turkish insurance sector would contribute significantly to the literature by testing the model's applicability in emerging economies.

Furthermore, most existing studies analyze specific periods using cross-sectional data, while longitudinal studies evaluating the impact of crisis periods or macroeconomic fluctuations on the model's predictive power remain limited. Increasing uncertainties in financial markets following the COVID-19 pandemic, in particular, necessitate a reassessment of the Altman Z-Score model's performance across different periods.

On the other hand, the Altman Z-Score model has mostly been applied using traditional statistical analyses. However, the increasing use of artificial intelligence, machine learning, and hybrid models in predicting financial failure in recent years highlights the need to integrate classical models with these new approaches. The lack of studies in the insurance sector that use the Altman model in conjunction with these modern methods presents new research opportunities from a methodological perspective. In this context, the current study aims to:

- ◆ To test the validity of the Altman Z-Score model by applying it specifically to the Turkish insurance sector,
- ◆ To adapt the model to the sector by including financial ratios specific to the insurance industry,
- ◆ contribute to the early prediction of financial failure risk.

In this respect, the study not only fills the existing gap in the insurance sector literature but also aims to establish a methodological basis for future comparative, multi-period, and artificial intelligence-supported research.

3. Research Methodology

This section introduces the mathematical and statistical models most frequently used in the literature for financial failure prediction; explains the theoretical framework of the model used in the analysis process; and presents the relevant analysis results and evaluations in the findings section.

3.1 Methods Used in Financial Failure Prediction: Altman Z-Score

Although numerous different models have been developed in the literature for predicting the financial failure of businesses, the most commonly used methods include the Altman Z-Score Model, Beaver Model, Springate S-Score Model, Fulmer H-Score Model, Ohlson O-Score Model, and Zmijewski J-Score Model [22–26]. In this study, the Altman Z-Score model was chosen from among these models. The reason for choosing this model is that it offers a structure based on multivariate discriminant analysis using accounting-based financial data and can quantitatively measure the risk of financial failure in businesses. Below are some basic details about the model's development and structure.

Edward I. Altman (1968) argued that traditional financial ratio analysis alone was insufficient for predicting corporate financial failure and developed a model based on multivariate discriminant analysis to overcome this limitation [5]. In his study, he examined the financial data of 33 successful and 33 unsuccessful (bankrupt) publicly traded companies in the manufacturing sector (bankruptcy) for the period 1946–1965. Altman tested the 22 financial ratios identified for these companies for their significance levels and grouped them into five main categories: profitability, liquidity, debt-paying power, financial leverage, and operating efficiency. Representative ratios selected from each group were weighted using coefficients obtained through discriminant analysis, and the sum of these values was defined as the company's Z-Score [4-5].

In the years following the model's introduction, various researchers debated its generalizability and sectoral applicability. In response to these criticisms, Altman developed three separate models to accommodate the financial structures of different sectors. These models are [5]:

- ◆ Publicly traded manufacturing sector companies,
- ◆ Non-publicly traded (privately owned) industrial companies,
- ◆ Three different versions of the Altman Z-Score developed for service sector companies.

This has transformed the model from one specific to the manufacturing sector into a versatile tool that can be used to measure the risk of financial failure for companies in different sectors.

The calculation formula and variables used in the Altman Z-Score model developed for publicly traded manufacturing companies are presented in Equation (1) [5].

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

X1: Net Working Capital / Total Assets
X2: Retained Earnings / Total Assets
X3: Pre-tax Profit / Total Assets
X4: Market Value of Equity / Total Liabilities

X5: Net Sales / Total Assets

The calculation formula and variables used in the Altman Z-Score model developed for privately owned industrial enterprises are presented in Equation (2) [24].

$$Z = 0.717 X1 + 0.847 X2 + 3.107 X3 + 0.420 X4 + 0.998 X5 \quad (2)$$

X1: Net Working Capital / Total Assets

X2: Retained Earnings / Total Assets

X3: Pre-tax Profit / Total Assets

X4: Book Value of Equity / Total Liabilities

X5: Net Sales / Total Assets

The calculation formula for the Altman Z-Score model, developed based on four key financial ratios for companies operating in the service sector, is presented in Equation (3) [28].

$$Z = 6.56 X1 + 3.26 X2 + 6.72 X3 + 1.05 X4 \quad (3)$$

X1: Net Working Capital / Total Assets

X2: Retained Earnings / Total Assets

X3: Pre-tax Profit / Total Assets

X4: Book Value of Equity / Total Liabilities

The Altman Z-Score reference values for these three models are presented comparatively in Table 2.

Table 2. Altman Z-score reference values [2-22-25]

Z-score values for publicly traded manufacturing companies	Z-score values for private industrial companies	Z-score values for service sector companies
Z>2.99 ; Successful (Low probability of bankruptcy) (Green zone)	Z>2.90; Successful (Low probability of bankruptcy) (Green zone)	Z >2.60; Successful (Low probability of bankruptcy) (Green zone)
1.81<Z<2.99; Uncertain (Gray zone)	1.23<Z<2.9; Uncertain (Gray zone)	1.10<Z<2.60 ;Uncertain (Gray zone)
Z<1.81; Failed (Red zone)	Z<1.23 ; Failed (Red zone)	Z<1.10;Failed (Red zone)

As indicated in Table 2, if the Z-Score value calculated for publicly traded manufacturing companies is greater than 2.99 ($Z > 2.99$), the company is financially successful and has a low risk of bankruptcy. If it is greater than 1.81 but less than 2.99 ($1.81 < Z < 2.99$), it means that the company is in an uncertain financial position and its financial situation needs to be monitored. If it is less than 1.8 ($Z < 1.81$), it is interpreted and evaluated as the company being financially unsuccessful with a high risk of bankruptcy. For private industrial companies, a Z-Score value greater than 2.90 ($Z > 2.90$) indicates that the company is financially successful and has a low risk of bankruptcy, while a value greater than 1.23 and less than 2.90 ($1.23 < Z < 2.90$), it means that the business is in a financially uncertain area and its financial situation needs to be monitored. If it is less than 1.23 ($Z < 1.23$), it is interpreted and evaluated as the business being financially unsuccessful and having a high risk of bankruptcy. For service sector businesses, a calculated Z-Score value greater than 2.60 ($Z > 2.60$) indicates that the business is financially successful and has a low risk of bankruptcy, while a value greater than 1.10 and less than 2.60 ($1.10 < Z < 2.60$), it means that

the company is in an uncertain financial position and its financial situation needs to be monitored. If it is less than 1.10 ($Z < 1.10$), it is interpreted and evaluated as the company being financially unsuccessful with a high risk of bankruptcy [22]. In financial failure prediction studies conducted using Altman Z-Score models, the Z-Score values calculated for businesses are compared with the reference values specified in Table 2, and evaluations are made for financial failure prediction.

3.2 Findings and Analysis

In this study, ten years of financial data from 2014 to 2023 for 37 non-life insurance companies operating in Turkey were used. The Altman Z-Score model, developed for the service sector, was applied to determine the probability of financial failure for the companies. The names of the companies included in the analysis have not been disclosed in accordance with the principle of confidentiality; each company has been coded as C1, C2, C3 ... C37, respectively.

The financial data used in the research was obtained from the financial statements published by the companies on open sources and their official websites. Four basic financial ratios required by the model were calculated for each company:

- ◆ X_1 : Ratio of net working capital to total assets,
- ◆ X_2 : Ratio of retained earnings to total assets,
- ◆ X_3 : Ratio of pre-tax profit to total assets,
- ◆ X_4 : Ratio of book value of equity to total liabilities.

Using these ratios, Z-Score values were calculated for each company on an annual basis using the following formula in Equation (4):

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

The obtained Z-Score values are presented in Table 3 and Figure 3 to show the change in the financial status of the companies over years.

Table 3. Calculated Z-score values for non-life insurance companies

Company	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Mean
C1									1,99	0,56	1,28
C2	1,85	1,29	1,61	1,70	1,61	1,59	1,49	1,50	1,05	1,26	1,50
C3	2,03	1,45	1,28	1,78	1,40	1,45	1,32	2,86	0,83	1,31	1,57
C4							3,82	4,02	1,48	1,28	2,65
C5	1,47	1,18	1,01	1,09	1,13	1,09	1,01	1,84	0,68	0,42	1,09
C6	3,90	3,57	3,28	1,38	2,16	1,77	1,87	2,23	0,83	0,86	2,18
C7								15,37	1,49	2,42	6,43
C8									1,93	1,06	1,49
C9	2,64	1,89	1,91	1,64	1,94	1,69	1,74	3,06	1,45	2,00	2,00
C10				1,57	0,90	1,16	1,26	1,32	0,47	0,93	1,09
C11						0,81	1,45	2,04	0,77	1,03	1,22
C12	1,92	1,49	1,59	0,56	0,58	1,17	1,35	2,28	0,60	0,75	1,23
C13									3,85	3,34	3,59
C14			1,50	1,55	1,20	1,07	1,63	2,19	0,80	0,93	1,36
C15	1,40	1,23	1,39	1,47	1,37	1,52	1,48	3,23	1,24	1,25	1,56
C16										4,50	4,50
C18	4,15	4,14	5,74	4,11	5,33	5,46	5,08	6,35	3,83	3,78	4,80
C18							10,87	-1,86	1,34	-	2,58

Company	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Mean
C19			8,66	3,38	2,84	2,73	2,41	4,09	1,40	1,15	3,33
C20	2,99	2,54	2,44	2,29	1,63	1,28	1,45	2,06	1,06	1,78	1,95
C21										1,27	1,27
C22	6,56	2,58	3,12	2,53	1,95	1,55	1,86	2,41	0,76	0,68	2,40
C23	15,49	13,98	11,84	0,35	2,01	1,38	1,47	1,01	1,81	1,00	5,03
C24	2,12	1,50	1,35	1,68	0,95	0,95	1,33	1,95	0,43	0,41	1,27
C25	6,11	2,43	1,81	1,77	2,35	3,55	3,95	6,29	2,87	2,01	3,31
C26									8,98	4,07	6,53
C27				1,18	0,94	0,97	1,53	1,80	1,26	1,40	1,30
C28	3,20	2,65	2,67	2,21	1,64	1,52	1,22	2,28	0,83	1,05	1,93
C29	1,03	0,71	0,80	1,38	1,20	1,25	1,21	2,83	0,57	1,21	1,22
C30				1,92	1,94	1,73	2,26	2,76	1,23	1,34	1,88
C31						14,75	1,03	-0,98	3,13	-	3,59
C32						2,59	1,79	2,72	1,09	0,91	1,82
C33	3,23	2,95	1,76	1,32	1,24	1,16	1,04	0,74	0,99	1,20	1,56
C34							2,05	3,43	0,70	1,05	1,80
C35		3,93	1,07	1,46	1,29	1,32	1,16	2,79	0,84	1,44	1,70
C36									1,89	1,98	1,93
C37	2,59	2,10	1,83	2,03	2,05	1,60	2,35	3,84	1,36	1,37	2,11
Average	3,69	2,87	2,83	1,75	1,72	2,20	2,15	2,88	1,59	1,43	2,31

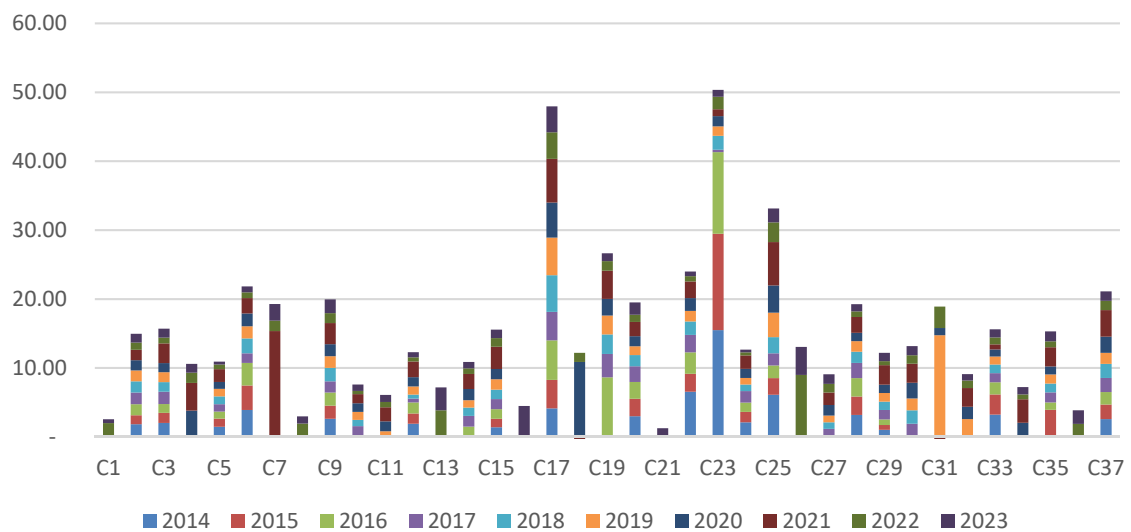


Figure 3. Companies' annual Z-Score value

The classification of non-life insurance companies' financial performance based on their calculated Z-Scores is shown in Table 4.

Table 4. Classification of financial performance based on calculated z-scores for non-life insurance companies

Company	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
C1									1,99	0,56
C2	1,85	1,29	1,61	1,70	1,61	1,59	1,49	1,50	1,05	1,26
C3	2,03	1,45	1,28	1,78	1,40	1,45	1,32	2,86	0,83	1,31
C4							3,82	4,02	1,48	1,28
C5	1,47	1,18	1,01	1,09	1,13	1,09	1,01	1,84	0,68	0,42
C6	3,90	3,57	3,28	1,38	2,16	1,77	1,87	2,23	0,83	0,86

Company	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
C7								15,37	1,49	2,42
C8									1,93	1,06
C9	2,64	1,89	1,91	1,64	1,94	1,69	1,74	3,06	1,45	2,00
C10				1,57	0,90	1,16	1,26	1,32	0,47	0,93
C11						0,81	1,45	2,04	0,77	1,03
C12	1,92	1,49	1,59	0,56	0,58	1,17	1,35	2,28	0,60	0,75
C13									3,85	3,34
C14			1,50	1,55	1,20	1,07	1,63	2,19	0,80	0,93
C15	1,40	1,23	1,39	1,47	1,37	1,52	1,48	3,23	1,24	1,25
C16										4,50
C18	4,15	4,14	5,74	4,11	5,33	5,46	5,08	6,35	3,83	3,78
C18							10,87	-1,86	1,34	-
C19			8,66	3,38	2,84	2,73	2,41	4,09	1,40	1,15
C20	2,99	2,54	2,44	2,29	1,63	1,28	1,45	2,06	1,06	1,78
C21										1,27
C22	6,56	2,58	3,12	2,53	1,95	1,55	1,86	2,41	0,76	0,68
C23	15,49	13,98	11,84	0,35	2,01	1,38	1,47	1,01	1,81	1,00
C24	2,12	1,50	1,35	1,68	0,95	0,95	1,33	1,95	0,43	0,41
C25	6,11	2,43	1,81	1,77	2,35	3,55	3,95	6,29	2,87	2,01
C26									8,98	4,07
C27				1,18	0,94	0,97	1,53	1,80	1,26	1,40
C28	3,20	2,65	2,67	2,21	1,64	1,52	1,22	2,28	0,83	1,05
C29	1,03	0,71	0,80	1,38	1,20	1,25	1,21	2,83	0,57	1,21
C30				1,92	1,94	1,73	2,26	2,76	1,23	1,34
C31						14,75	1,03	-0,98	3,13	-
C32						2,59	1,79	2,72	1,09	0,91
C33	3,23	2,95	1,76	1,32	1,24	1,16	1,04	0,74	0,99	1,20
C34							2,05	3,43	0,70	1,05
C35		3,93	1,07	1,46	1,29	1,32	1,16	2,79	0,84	1,44
C36									1,89	1,98
C37	2,59	2,10	1,83	2,03	2,05	1,60	2,35	3,84	1,36	1,37
	Successful		Unclear		Unsuccessful					

As indicated in Table 4, a total of 255 Z-Score values were calculated for the companies for the period under review. Based on these values, 56 were unsuccessful (22%), 56 were successful (22%), and 143 were uncertain (56%). Furthermore, considering these Z-Score values, it can be said that the financial success of companies is gradually shifting towards uncertainty over the years. Numerical data showing the success status of companies during their operating period, based on Z-Score values for the companies examined, are provided in detail in Table 5.

Table 5. Numbers related to the financial performance of non-life insurance companies based on their Z-scores

Company	Successful	Uncertain	Unsuccessful	Company	Successful	Uncertain	Unsuccessful
C1	0	1	1	C20	1	8	1
C2	0	10	0	C21	0	1	0
C3	1	8	1	C22	2	6	2
C4	2	2	0	C23	3	4	3
C5	0	4	6	C24	0	6	4
C6	3	5	2	C25	5	5	0
C7	1	2	0	C26	2	0	0
C8	0	1	1	C27	0	5	2

C9	2	8	0	C28	3	5	2
C10	0	4	3	C29	1	5	4
C11	0	2	3	C30	1	6	0
C12	0	6	4	C31	2	0	3
C13	2	0	0	C32	1	2	2
C14	0	5	3	C33	2	5	3
C15	1	9	0	C34	1	1	2
C16	1	0	0	C35	2	5	2
C17	10	0	0	C36	0	2	0
C18	1	1	2	C37	1	9	0
C19	5	3	0				

5. Discussion & Conclusion

In this study, the financial failure situations of 37 non-life insurance companies operating in Turkey were analyzed using financial data from the 2014–2023 period and the Altman Z-Score model developed for the service sector. Z-Score values were calculated for each company, and financial success, failure, and uncertainty situations were determined based on these values. During the analysis process, since not all companies were active throughout the study period, only the years in which they were active were considered. Thus, a total of 255 Z-Score values were calculated over the ten-year study period (see Table 4). According to the results obtained, 22% of the companies were financially unsuccessful, 22% were successful, and 56% were in the uncertainty zone. These findings show that there is a trend towards uncertainty in the financial situation of companies over the years. In other words, while the sector generally presented a stronger financial outlook in its early years, this picture weakened towards the end of the period, with an observed increase in the likelihood of uncertainty and failure. This situation indicates that financial risks in the non-life insurance sector have entered an upward trend over time. The calculated Z-Score values range from 0.35 to 15.37, and it has been determined that the annual average values vary between 3.69 and 1.43. When examining the average Z-Score values of the companies, the highest average was 3.69 in 2014, and the lowest average was 1.43 in 2023. This result indicates a downward trend in the sector's financial soundness over time. When comparing the annual average Z-Score values with the model's reference ranges, it was found that nonlife insurance companies were financially successful in 2014, 2015, 2016, and 2021, while they were mostly in the uncertainty zone in other years. Therefore, it is not possible to speak of a clear trend of success regarding the sector's financial situation throughout the analysis period. Furthermore, it was determined that no company showed continuous financial failure throughout the period, but some companies entered a risky position in certain years. Examining Table 5, it is seen that only company C17 was financially successful in all years during the 2014–2023 period. However, company C19 was successful five times and unsuccessful three times, while company C25 was successful five times and in the uncertainty zone five times. The financial performance of these companies is considered to be above average. In terms of financial failure risk, company C5 was unsuccessful six times, while companies C12, C24, and C29 were unsuccessful four times each. It can be stated that these companies carry a risk of bankruptcy. When examining the companies that were in the uncertainty zone the most, it was seen that Company 2 was in the uncertainty zone 10 times, Company 37 was in the uncertainty zone 9 times, and Companies 3, 9, and 20 were in the uncertainty zone eight times each. This finding indicates that the financial structures of these companies followed an unstable course. For companies in the uncertainty zone, when Z-Score values are close to the financial success threshold, it is considered useful to conduct additional assessments using alternative financial failure measurement models (e.g., logit/probit analyses or

artificial intelligence-based classification methods). It was determined that 12 of the 37 companies examined during the research period did not achieve financial success in any given year. When a general assessment is made, it is seen that a significant portion of the companies are concentrated in the uncertainty zone. The findings obtained are limited by the scope and period of the study. A review of existing studies in the literature reveals that the Altman Z-Score model is generally applied to businesses outside the insurance sector, while studies related to the insurance sector focus on fewer companies and shorter time periods. In this context, this study's comprehensive analysis of 37 non-life insurance companies operating in Turkey over a long period of 10 years provides a unique and in-depth contribution to the literature.

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