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FINANCIAL FAILURE RISK OF SOME COMPANIES IN THE ISTANBUL STOCK EXCHANGE AUTOMOTIVE SECTOR: ANALYSIS USING ALTMAN Z-SCORE AND SPRINGATE S-SCORE MODELS, 2016–2024

Assistant Professor Sinan GÜLENÇER[1]

Abstract

Turkey's automotive industry stands out in the Turkish economy due to its high value added, exports, and employment. Yet it is prone to financial fragilities. This is mainly because production is capital intensive, supply chains are global, and exchange rates and interest rates are volatile. This study aims to measure and compare financial distress risk for automotive and automotive supplier-industry firms listed on Borsa Istanbul (BIST) over 2016–2024. It uses the Altman Z-Score and Springate S-Score models and constructs a sectoral risk map. The analysis is conducted in Microsoft Excel. The sample includes eight firms with continuous data (TTRAK, TOASO, TMSN, OTKAR, KARSN, FROTO, DOAS, ASUZU). Annual financial statements are obtained from the Public Disclosure Platform (KAP). Firm-year scores indicate clear divergence in risk profiles. Ford Otosan, Doğuş Otomotiv, and Türk Traktör are mostly in the safe zone under both models and form the sector's resilient core. Tofaş, Tümosan, and Otokar fluctuate in the grey zone (moderate-risk band) and appear more sensitive to macroeconomic shocks. Karsan and Anadolu Isuzu remain largely in the distress zone, suggesting structural fragility. Methodologically, the Springate S-Score yields more conservative results and signals weakening short-term debt-servicing capacity earlier. Overall, combining balance-sheet-oriented and operating-profitability-oriented score models provides a stronger early-warning tool for managers and investors in capital-intensive sectors. It can support proactive strategies on liquidity, profitability, and debt maturity structure. It also facilitates within-sector comparison and risk classification.

Keywords: *Altman Z-Score, Springate S-Score, Financial Distress, Automotive Sector, Borsa Istanbul.*

BORSA İSTANBUL OTOMOTİV SEKTÖRÜNDE YER ALAN BAZI FİRMALARIN FİNANSAL BAŞARISIZLIK RİSKİ: ALTMAN Z-SKOR VE SPRİNGATE S-SKOR MODELLERİYLE 2016–2024 ANALİZİ

Özet

Türkiye ekonomisinde yüksek katma değer, ihracat ve istihdam kapasitesiyle öne çıkan otomotiv sektörü; sermaye yoğun üretim yapısı, küresel tedarik zincirlerine bağımlılığı ve kur/faiz oynaklığı nedeniyle finansal kırılganlıklara açıktır. Bu çalışmanın amacı, Borsa İstanbul'da (BİST) işlem gören otomotiv ve otomotiv yan sanayi şirketlerinin finansal başarısızlık riskini Altman Z-Skor ve Springate S-Skor modelleriyle 2016–2024 dönemi için karşılaştırmalı olarak ölçmek ve sektörel bir risk haritası oluşturmaktır. Çalışma için Microsoft Excel programı kfaydalanılmıştır. Örneklem, veri sürekliliği sağlanan sekiz şirketten (TTRAK, TOASO, TMSN, OTKAR, KARSN, FROTO, DOAS, ASUZU) oluşmakta; analizler Kamuyu Aydınlatma Platformu'ndan elde edilen yıllık finansal tablolarla yürütülmektedir. Her firma-yıl için hesaplanan skorlar, şirketlerin risk profillerinde belirgin ayrışmalar bulunduğunu ortaya koymaktadır. Bulgular, Ford Otosan, Doğuş Otomotiv ve Türk Traktör'ün iki modele göre de çoğunlukla güvenli bölgede yer alarak sektörün en dirençli çekirdeğini oluşturduğunu göstermektedir. Tofaş, Tümosan ve Otokar gri/orta risk bandında dalgalanmakta ve makroekonomik şoklara daha duyarlı bir profil sergilemektedir. Karsan ve Anadolu Isuzu ise ağırlıklı olarak risk bölgesinde kalarak yapısal kırılganlığı işaret etmektedir. Yöntemsel karşılaştırmada Springate S-Skor daha muhafazakâr sonuçlar üretmiş ve kısa vadeli borç ödeme kapasitesindeki bozulmaları daha erken sinyalize etmiştir. Sonuçlar, sermaye yoğun

[1] Eskişehir Osmangazi University, Health Services Vocational School, sinang@ogu.edu.tr, ORCID ID: 0000-0001-7406-1023

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sektörlerde bilanço odaklı ve operasyonel kârlılık temelli modellerin birlikte kullanılmasının, yöneticiler ve yatırımcılar için daha etkili bir erken uyarı ve izleme mekanizması sunduğunu; likidite, kârlılık ve borç vade yapısına ilişkin proaktif stratejilerin tasarlanmasına katkı sağlayabileceğini göstermektedir. Bu çerçevede sektör içi karşılaştırma ve risk sınıflaması kolaylaşmaktadır.

***Anahtar Kelimeler**: Altman Z-Skor, Springate S-Skor, Finansal Başarısızlık, Otomotiv Sektörü, Borsa İstanbul.*

1. INTRODUCTION

The automotive industry holds a strategic position in the Turkish economy in terms of production volume, export performance, employment capacity, and technology level. When considered together with its ancillary industries, automotive is one of the few sectors within the manufacturing industry that has a high share and is capable of generating a foreign trade surplus. The fact that many global brands have positioned Turkey as a production and export base makes the sector critical not only in terms of domestic market dynamics but also in terms of integration into global value chains. Therefore, the financial health and sustainability of automotive companies are of great importance not only for the companies themselves but also for macroeconomic stability, foreign trade balance, and the preservation of skilled employment.

Behind the high added value that the automotive sector provides to the economy, there are also significant financial risk factors. Production lines requiring high fixed capital investments, extensive inventory and dealer structures, intensive R&D expenditures, and the need for foreign currency financing force company balance sheets into a delicate balance in terms of both asset composition and debt levels. Demand contractions, volatility in exchange rates and interest rates, increases in commodity prices, and changes in the regulatory framework can rapidly affect the profitability and cash flows of automotive companies; this situation can increase the risk of financial failure, especially for companies operating with high leverage (Beaver, 1966; Altman, 1968). Therefore, while the sector offers high added value and export potential on the one hand, it is also one of the areas where financial fragility is most rapidly apparent. Due to high production volumes, strong export performance, extensive supply chains, and connections to ancillary industries, financial problems in the sector can simultaneously affect not only the companies involved but also many other areas, from employment and tax revenues to logistics and the financial sector. Large-scale manufacturing companies and distributors, in particular, are exposed to fluctuations in both domestic demand and foreign market conditions, resulting in their balance sheets being intertwined with currency risk, interest rate risk, and liquidity risk. Therefore, automotive companies need to design their capital structure, borrowing terms, foreign exchange positions, and working capital policies from a holistic risk management perspective.

In this context, establishing the correct relationship between efficiency and corporate performance sustainability and the level of financial risk in automotive companies is of critical importance. In companies operating in a capital-intensive, technology and R&D-focused structure, strategies aimed at increasing production efficiency and capacity utilization rates may fail to achieve the expected performance gains on a sustainable basis unless they are supported by sufficient financial resilience and a strong balance sheet structure. Conversely, companies with robust liquidity, profitability, and capital structure indicators can respond more flexibly to demand shocks and market fluctuations, making investment and renewal decisions from a long-term perspective. In this context, measuring the financial risk profiles of automotive and automotive manufacturing companies traded on the Istanbul Stock Exchange using early warning models such as the Altman Z-Score and Springate S-Score provides an important

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analytical framework for revealing the extent to which efficiency and performance-oriented strategies are built on a solid financial foundation (Altman, 1968; Springate, 1978).

An examination of the sector's financial structure reveals that high fixed investments, a stock-intensive business model, and the frequent need for foreign currency borrowing make automotive companies particularly sensitive to leverage, exchange rate, and liquidity risks. The main measures to be taken in this context are: maintaining the debt/equity ratio at sustainable levels, reducing refinancing risk by extending the maturity structure of short-term debt as much as possible, limiting foreign exchange open positions through natural hedging and derivative products, and managing interest rate risk through a fixed/variable interest rate composition and, when necessary, interest rate swaps. In addition, activating working capital management, improving receivables and inventory turnover rates, and regularly analyzing cash flows through scenario and stress tests will contribute to the early detection of financial failure risk. The regular use of early warning models such as the Altman Z-Score and Springate S-Score within this framework serves as a complementary tool that enables automotive companies to monitor financial risks in a transparent and comparable manner, both in their own internal monitoring processes and in their relationships with investors and creditors (Türk & Kürklü, 2017; Yetik, 2024).

2. THEORETICAL FRAMEWORK

Financial failure is defined as the inability of a company's cash flows to meet its financial obligations, leading to outcomes such as bankruptcy, liquidation, or forced restructuring, and is considered a critical issue that affects not only the company's partners but also its employees, suppliers, creditors, and economic stability on a broader scale (Beaver, 1966; Yetik, 2024). The ability to detect early signs of financial distress enables management to take proactive measures and stakeholders to manage their risks. For this reason, "financial failure models" are widely used as a type of early warning system in both academic writing and practice (Altman, 1968; Ohlson, 1980). The literature offers a wide range of methods, from traditional single-ratio-based analyses to multivariate discriminant analysis, logit/probit models, scorecards, and, more recently, machine learning applications (Beaver, 1966; Ohlson, 1980; Zmijewski, 1984). In this context, ratio-based scoring models stand out because they aggregate multiple financial ratios under a single composite score, positioning the company's risk of financial failure on a quantitative and comparable axis (Altman, 1968; Türk & Kürklü, 2017).

Beaver (1966), one of the precursors of ratio-based models, demonstrated the ability of specific financial ratios to distinguish between bankrupt and non-bankrupt firms with his single-variable approach. Subsequently, Altman (1968) developed a model that combined a series of financial ratios under a single Z-score using multivariate discriminant analysis. The Altman Z-Score model is a linear combination of five ratios: working capital/total assets, retained earnings/total assets, EBIT/total assets, market value of equity/total liabilities, and sales/total assets. Companies are classified into "safe zone," "gray zone," and "danger zone" based on the comparison of the obtained score with specific threshold values (Altman, 1968; Altman & Hotchkiss, 2006). In the classic model, a Z-score below 1.81 indicates the danger zone with a high risk of financial failure, between 1.81 and 2.99 indicates the gray zone, and above 2.99 indicates the safe zone (Altman, 1968). In subsequent years, the model was adapted into different versions (Z', Z") for use in both non-manufacturing sectors and emerging markets; formulations based on the book value of equity were developed, particularly for samples with limited access to market value (Altman, 2005; Altman & Hotchkiss, 2006; Yetik, 2024). Thus, the Z-Score model combines different dimensions such as liquidity, profitability, capital

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structure, and asset utilization efficiency into a single indicator, providing a framework for a comprehensive assessment of medium- to long-term bankruptcy risk.

The Springate (1978) model, while based on the Altman approach, has developed a simpler structure consisting of four ratios with the highest discriminatory power. The Springate S-Score model produces a composite score by weighting the ratios of working capital/total assets, earnings before interest and taxes/total assets, earnings before taxes/short-term debt, and sales/total assets with specific coefficients (Springate, 1978; Boritz, Kennedy, & Sun, 2007). In the model, an S-Score above the threshold value of 0.862 is interpreted as financially sound, while a score below this value is interpreted as a risk of financial failure (Springate, 1978; Yetik, 2024). Additionally, the S-Score focuses on debt repayment capacity, particularly through the ratio of pre-tax profit to short-term liabilities; therefore, it serves as an early warning indicator that is more sensitive to short-term liquidity pressures and deterioration in operating profitability. The fact that data such as market value is not mandatory and that it can be calculated using only balance sheet and income statement information increases the applicability of the model for privately held companies or companies with limited data access (Boritz et al., 2007; Büyükarıkan & Büyükarıkan, 2014). Thus, the Altman Z-Score offers a perspective that focuses more on balance sheet structure and asset-based profitability, while the S-Score offers a complementary perspective that emphasizes operational profitability and short-term debt repayment capacity.

In the international literature, models such as the Altman Z-Score, Springate S-Score, Ohlson O-Score, and Zmijewski X-Score have been extensively applied to measure the risk of financial failure for companies in the manufacturing industry, service sector, SMEs, and various country stock markets (Ohlson, 1980; Zmijewski, 1984; Adalessossi, 2015; Elviani, 2020). Studies conducted specifically on the automotive sector also show that these score models are an important tool for distinguishing between bankruptcy and financial distress risk due to the sector's capital-intensive structure, high fixed investment requirements, need for inventory financing, and sensitivity to exchange rate/interest rate volatility (Mahardika & Setyawan, 2022; Patel, Jalota, & Sharma, 2021). Studies conducted on the Istanbul Stock Exchange in Turkey show that the Altman and Springate models are used to measure the risk of financial failure for companies in different sectors such as energy, textiles, healthcare, sports, and information technology; it has been found that low scores are generally associated with insufficient liquidity, weak profitability, and high leverage (Bağcı & Sağlam, 2019; Fidan, 2021; Gülencer & Hazar, 2020; Kulalı, 2016; Büyükarıkan & Büyükarıkan, 2014; Yaman & Korkmaz, 2021).

When looking at the literature specific to the BIST automotive sector, it is seen that the number of studies using both the Altman Z-Score and Springate S-Score models together and examining the sector's financial risk profile has increased, but is still limited. Şahin and Özkan (2022) compared the Altman Z-Score, Springate S-Score, Taffler T-Score, and Zmijewski X-Score models using data from 2017–2021 for eight automotive manufacturing companies listed on the Istanbul Stock Exchange. They found that the Z and S scores generally gave similar signals and that companies were less negatively affected financially than expected during the COVID-19 period. Yetik (2024), on the other hand, used the Altman Z'' and Springate models for the same eight BIST automotive companies for the 2020–2024 period and found that companies such as DOAS, FROTO, TOASO, and TTRAK produced strong scores according to both models, while KARSN was in the financial distress zone in both models; while the Z and S scores diverged for some companies. Furthermore, studies on different BIST sectors using both Altman and Springate models together revealed that the models often gave parallel signals, but sometimes gave different signals, especially during periods of increased short-term

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liquidity and profitability pressures. This situation indicates that the risk of financial failure can be more accurately assessed by evaluating multiple models together rather than using a single score model (Akdeniz & Güven, 2023; Bağcı & Sağlam, 2019; Fidan, 2021; Aslan, 2024).

Within this theoretical framework, the Altman Z-Score and Springate S-Score models are positioned as suitable and complementary tools for measuring the risk of financial failure of automotive and automotive manufacturing companies traded on the Istanbul Stock Exchange and for creating a comparative financial risk map between companies. While the Z-Score model focuses on medium- to long-term bankruptcy risk through balance sheet structure and asset-based profitability, the S-Score model is more sensitive to operating profitability and short-term debt repayment capacity, reflecting operational risks earlier, especially during periods of increased liquidity pressures. Therefore, considering the high value-added and outward-oriented structure of the Turkish automotive industry, its exposure to exchange rate and interest rate fluctuations, and its widespread impact on the economy through extensive supply chains, the joint analysis of Z and S scores throughout the 2016–2024 period provides an important theoretical and empirical contribution to understanding the multidimensional and time-dimensional financial resilience, fragility, and performance dynamics of companies in the sector (Şahin & Özkan, 2022; Yetik, 2024).

3. LITERATURE

Springate (1978) developed the S-Score model using multivariate discriminant analysis based on data from 40 bankrupt and 40 non-bankrupt companies operating in Canada. The study revealed that Springate's model, which includes four financial ratios, can predict companies' financial failure with approximately 92.5% accuracy and is particularly sensitive to short-term debt repayment capacity.

Anginer, Demirgüç-Kunt, and Zhu (2014) examined the effect of competition in the banking sector on systemic risk using panel data from approximately 2,000 banks in 50 countries for the period 1989–2010 and used the Z-Score as a risk indicator. According to the findings of the study, as competition among banks increases, banks' Z-Scores decline, indicating an increase in systemic risk.

Almamy, Aston, and Ngwa (2016) used the Altman Z-Score model in conjunction with cash flow ratios to predict bankruptcies during the global financial crisis of the 2000s for publicly traded companies operating in the United Kingdom. The study revealed that adding cash flow-based ratios to the traditional Z-Score model significantly increased the predictive power of financial failure, especially during crisis periods.

Kulalı (2016) applied the Altman Z-Score model using the financial statements of companies from different sectors traded on the Istanbul Stock Exchange for the 2010s and compared the risk of financial failure of companies by sector. The study showed that companies with high leverage and low profitability were concentrated in the danger zone, while companies with a strong equity structure and stable profitability were in the safe zone.

Türk and Kürklü (2017) measured the levels of financial failure using the Altman Z-Score and Springate S-Score models, using data from 166 companies in 7 different sectors listed on the Istanbul Stock Exchange for the 2014–2016 period. The study revealed that both models classified many companies as gray or risky; however, the Springate S-Score gave a higher rate of financial failure signals compared to the Z-Score and therefore corresponded to a more cautious model.

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Öztürk and Yılmaz (2019) examined the relationship between the Altman Z-Score and the Beneish M-Score for 17 companies traded on the Borsa Istanbul Emerging Companies Market, thereby testing the link between financial distress and possible accounting manipulation. The results reveal that as the Z-Score level decreases, the Beneish M-Score shows a tendency to deteriorate, suggesting that an increased risk of financial failure may exert pressure on financial reporting quality.

Altan and Şimşek (2023) assessed the risk of financial failure using the Fulmer H and Springate S-Score models, based on the financial statements of healthcare companies listed on the Istanbul Stock Exchange for the period 2012–2021. According to the findings of the study, while some companies were close to the financial distress zone according to the Springate model, it was found that the S-Score remained in the safe zone, especially for companies with strong profitability and liquidity.

Medetoğlu and Tekin (2023) predicted financial failure using the Springate S-Score and Fulmer H models based on the financial data of companies in the BIST Textile, Clothing, and Leather Sector for the 2015–2021 period. The results show that while the S-Score model classifies some firms as risky, the Fulmer H model gives a lower rate of financial failure signals; thus, there is a clear difference between the models in terms of conservatism level.

Aslan (2024) measured the risk of financial failure by analyzing the financial statements of 13 companies operating in the electricity production sector on the Istanbul Stock Exchange for the period 2012–2022 using the Altman Z-Score method. The study emphasizes that a significant portion of the companies in the sample are in the gray zone, while some companies remaining in the danger zone for a long time indicate structural financial problems.

Yılmaz (2024) applied the Altman Z and Springate S-Score models comparatively to the financial data of 26 companies operating in the BIST Textile, Clothing, and Leather Sector for the 2020–2023 period. The findings show that, according to the Z-Score model, a significant portion of the companies are in the gray zone, while some are in the danger zone; the Springate model, on the other hand, produces harsher warnings, especially for companies with low profitability and high short-term debt burdens. The study emphasizes that the combined use of the two models allows for a more comprehensive view of the sector's financial failure risk.

Yetik (2024), in the book chapter titled "Financial Failure Risk Prediction in the BIST Automotive Sector: Altman Z'' and Springate Models," applied both the Altman Z'' and Springate S-Score models for automotive and automotive manufacturing companies listed on the Istanbul Stock Exchange for the 2020–2024 period. The study shows that companies such as DOAS, FROTO, TOASO, and TTRAK scored relatively high on both models; in contrast, companies such as KARSN showed a significant risk of financial distress, particularly according to the Springate model, and emphasizes that the two models are complementary in the context of the automotive sector.

Yıldırım (2025) compared the Springate S-Score and Fulmer H models for a large number of companies traded on the Istanbul Stock Exchange and calculated financial failure rates based on a dataset of 170 observations. The study emphasizes that, according to the Springate model, approximately 44% of companies are at risk of financial failure, while according to the Fulmer H model, this rate remains around 6%, thus highlighting that the S-Score is a more "rigorous" early warning indicator.

Rafiqi (2025) used the Springate S-Score model along with other ratio-based models to predict financial distress for Islamic banks in Indonesia and analyzed panel data from 2013–

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2019. The findings show that S-Score values are above the threshold value of 0.862 for most banks and that the Islamic banking system generally exhibits a financially resilient outlook.

4. METHOD

This study analyzes the financial failure risks of automotive and automotive manufacturing companies traded on the Istanbul Stock Exchange using the Altman Z-Score and Springate S-Score models. The research dataset was compiled from annual financial statements (balance sheets and income statements) published on the Public Disclosure Platform (KAP). The period under review was selected as 2016–2024 to ensure data continuity and to cover the currency shocks, pandemic, and high inflation experienced in recent years. The universe of the study consists of automotive and automotive manufacturing companies listed on the Istanbul Stock Exchange during the period in question and for which full data access is available. Within this scope, the companies included are Türk Traktör ve Ziraat Makineleri A.Ş. (TTRAK), Tofaş Türk Otomobil Fabrikası A.Ş. (TOASO), Tümosan Motor ve Traktör Sanayi A.Ş. (TMSN), Otokar Otomotiv ve Savunma Sanayi A.Ş. (OTKAR), Karsan Automotive Industry and Trade Inc. (KARSN), Ford Otomotiv Sanayi Inc. (FROTO), Doğuş Otomotiv Servis ve Ticaret Inc. (DOAS), and Anadolu Isuzu Otomotiv Sanayi ve Ticaret Inc. (ASUZU). When creating the data set , relevant items were extracted from the annual financial statements published on KAP as of December 31 for each company, and data integrity was ensured by checking for missing or inconsistent observations for each year. In the study, the financial statements were used as announced on KAP; macroeconomic conditions during the relevant periods were taken into account in the discussion section when interpreting the model results.

During the analysis process, the ratios included in the Altman Z-Score model (working capital/total assets, retained earnings/total assets, earnings before interest and taxes/total assets, equity/total debt, and sales/total assets) were derived from the financial statements and annual scores were calculated using the Z formula used for traditional manufacturing companies.

$$Z=1.2X1+1.4X2+3.3X3+0.6X4+1.0X5 \quad (1)$$

The obtained Z-Score value is interpreted within the thresholds defined by Altman:

- $Z < 1.81$: Danger zone (high risk of financial failure/bankruptcy)
- $1.81 \leq Z < 2.99$: Gray zone (moderate risk requiring monitoring)
- $Z \geq 2.99$: Safe zone (low risk of financial failure)

For the Springate S-Score model, the following ratios were calculated: working capital/total assets, interest and tax-adjusted profit/total assets, pre-tax profit/short-term liabilities, and sales/total assets. These ratios were weighted using the coefficients recommended by Springate to obtain S scores for each company-year.

$$S=1.03A+3.07B+0.66C+0.40D \quad (2)$$

In the Springate model, the basic threshold value used for the S-Score is:

- $S > 0.862$: Financially healthy businesses
- $S \leq 0.862$: Businesses at risk of financial failure

5. FINDINGS

The Z and S scores obtained in the study were analyzed using descriptive statistics, year-based tables, and trend graphs. First, the time series of Z and S scores for each company during the 2016–2024 period was examined; then, inter-company comparisons were made for the same

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year to identify strong, moderate, and vulnerable groups within the sector. Thus, by evaluating the results obtained from the Altman and Springate models together, the compatibility and points of divergence between the balance sheet-focused (Z-Score) and the operating profitability and short-term debt repayment capacity-focused (S-Score) perspectives on the same sample were revealed.

Table 1. Altman Z-Score Table for BIST Automotive Companies

Year	TTRAK	TOASO	TMSN	OTKAR	KARSN	FROTO	DOAS	ASUZU
016	2,940	1,829	3,620	1,609	0,427	3,005	2,860	1,671
2017	2,800	1,984	3,191	1,728	0,817	3,165	3,048	1,297
2018	2,440	2,313	1,696	1,728	0,750	3,603	2,821	1,099
2019	2,440	2,589	1,440	2,205	1,052	3,457	2,745	1,356
2020	2,900	2,077	1,905	1,797	1,415	3,378	3,826	1,118
2021	3,390	2,358	1,602	1,937	1,242	3,027	1,621	1,527
2022	2,710	2,709	2,625	1,314	0,266	2,906	4,550	1,550
2023	3,970	3,265	2,956	1,639	0,651	3,130	5,342	1,698
2024	3,580	2,845	2,169	1,482	0,679	2,952	4,348	1,819

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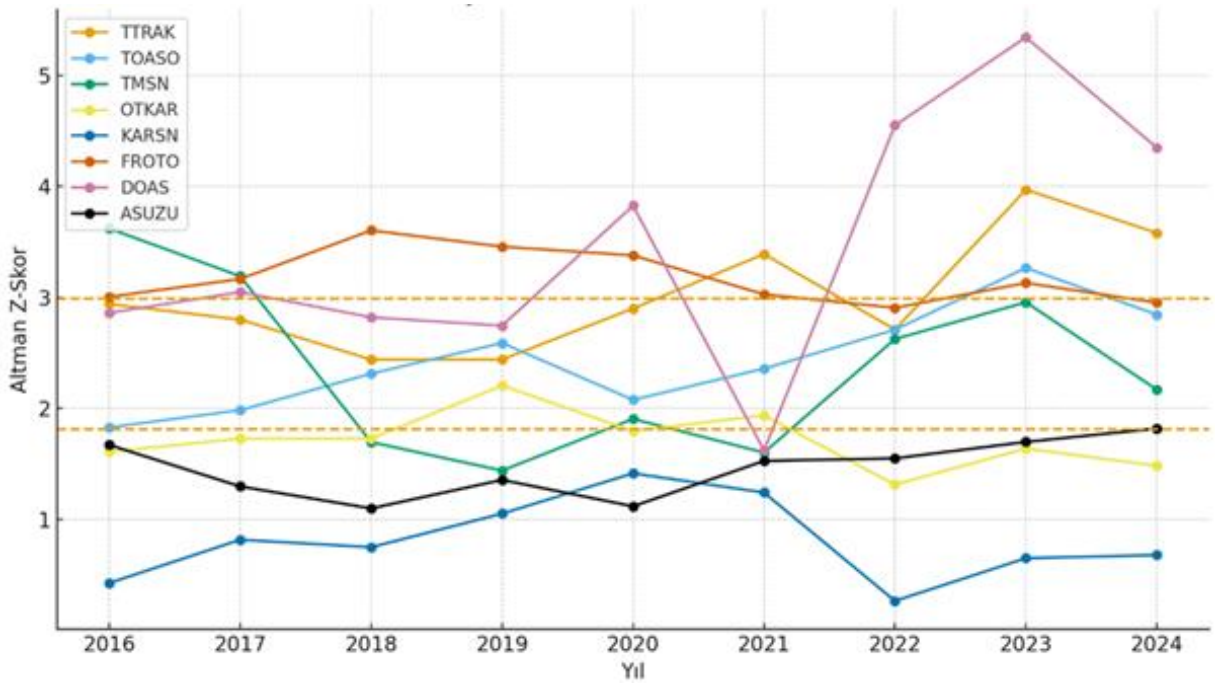
Figure 1. Temporal Change in Altman Z-Score Values of BIST Automotive Companies



The Altman Z-score table reveals a clear divergence in financial risk levels among automotive and automotive manufacturing companies. Considering the threshold values, Ford Otosan, Doğuş Otomotiv, and Türk Traktör stand out as the relatively strongest group, distinguishing themselves from other companies throughout the period. Ford Otosan's Z-scores indicate a consistently strong financial profile over the 2016–2024 period. The firm is classified in the safe zone in seven of the nine years, remaining above the 2.99 threshold (2016–2021 and 2023). The score declines into the gray zone in only two years (2022: 2.906; 2024: 2.952); however, since these values are very close to the safe-zone cut-off, this decline is more appropriately interpreted as a limited and temporary weakening rather than a structural deterioration. Doğuş Otomotiv's scores have also risen dramatically since 2020, particularly exceeding 4 in the 2022–2024 period, indicating financial strength beyond the levels considered safe by the model; the temporary deterioration seen in 2021 was offset by the high scores that followed immediately afterwards. Türk Traktör, on the other hand, is in the upper band of the gray zone or in the safe zone in most years; in particular, values above 3 in 2021, 2023, and 2024 reveal that the company is also part of this core strong group and is positioned among companies with low bankruptcy risk in automotive manufacturing.

Tofaş, Tümosan, and Otokar, which are in the middle group in terms of Altman Z, are generally resilient companies, but their periodic vulnerabilities are more pronounced. Tofaş's Z scores are predominantly in the gray zone, rising to the safe zone only in 2023; despite its relatively low starting level in 2016, this profile, which has strengthened over time, suggests that the company has never been at serious risk, but has a slightly more fragile structure compared to core strong companies. Tümosan's Z-scores fluctuate considerably over the years; while strong values above 3 are seen in 2016–2017, scores fall into the danger zone in 2018–2019 and 2021, rising back to the gray zone in some years. These fluctuations indicate that the company has at times exhibited a very strong financial structure and at other times a structure close to the brink of bankruptcy, and that its profitability is sensitive to shocks. At Otokar, Z scores mostly hovered between the danger zone and the gray zone, only reaching the gray zone in 2019 and 2021; this reveals that the company has a profile that is risky according to the

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Altman model but has the potential for periodic recovery. Karsan and Anadolu Isuzu are the most fragile companies in this table. Karsan's Z-scores remain below the 1.81 threshold in all years examined, with only a limited increase seen in 2020, yet failing to reach even the gray zone; this indicates that the company carries a structurally high risk of financial failure/bankruptcy throughout the period. Anadolu Isuzu also spent the 2016–2023 period continuously in the danger zone, only touching the lower limit of the gray zone in 2024 with a value of 1.819; this indicates that the company is structurally fragile but has entered a very limited improvement trend in the last year. Overall, the Z-score table presents a sector picture that can classify Ford Otosan, Doğuş Otomotiv, and Türk Traktör as the low-risk core group; Tofaş, Tümosan, and Otokar as the medium-risk group; and Karsan and Anadolu Isuzu as the most fragile group.

Table 2. Springate S-Score Values of BIST Automotive Companies

Year	TTRAK	TOASO	TMSN	OTKAR	KARSN	FROTO	DOAS	ASUZU
Year	TTRAK	TOASO	TMSN	OTKAR	KARSN	FROTO	DOAS	ASUZU
2016	1,950	0,828	1,469	0,913	0,165	1,345	1,265	0,635
2017	1,670	0,923	0,557	1,045	0,648	1,509	1,290	0,352
2018	1,460	1,077	0,270	1,123	0,521	1,717	1,214	0,321
2019	1,190	1,216	0,168	1,510	0,671	1,653	1,171	0,590
2020	1,820	1,026	0,783	1,233	1,026	1,852	2,008	0,444
2021	2,030	1,321	0,618	1,308	0,818	1,907	0,491	0,737
2022	1,440	1,397	0,934	0,609	0,289	1,530	2,864	0,480
2023	2,590	1,867	1,337	0,718	0,504	1,756	3,440	0,681

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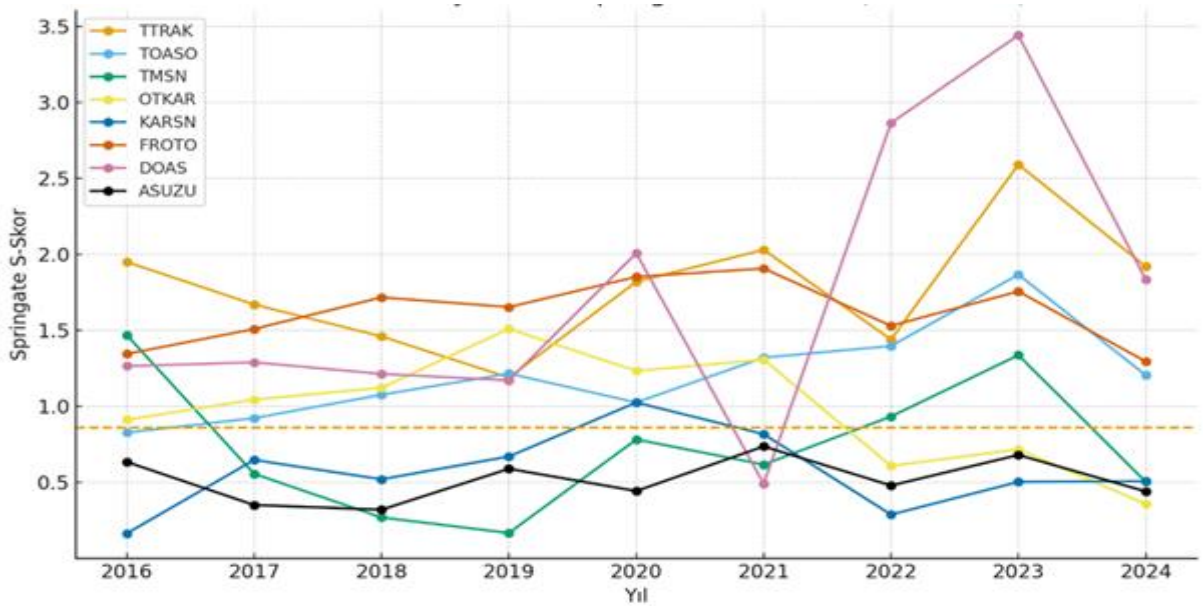
Figure 2. Temporal Change in Springate S-Score Values of BIST Automotive Companies



The Springate S score table reveals a similar differentiation at the operational level, primarily based on operating profitability and short-term debt repayment capacity. Companies above the threshold value are interpreted as those that can comfortably meet their short-term obligations with their profit and cash generation capacity, while scores below the threshold indicate a risk of financial failure. From this perspective, the S scores of Ford Otosan, Doğuş Otomotiv, and Türk Traktör, consistent with their Z scores, place them among the most comfortable companies in the sector in operational and financial terms. Ford Otosan consistently scores well above the 0.862 threshold, mostly in the 1.5–2 range, indicating that the company's operating profit and pre-tax profit provide a high buffer against short-term liabilities. Doğuş Otomotiv also shows quite high S scores in the 2016–2020 and 2022–2024 periods, with values above 2 and even 3, especially after 2020, revealing that the company's cash generation capacity and debt conversion power have reached an extremely strong level. The low value in 2021 indicates a temporary disruption, but it is balanced by a strong recovery immediately afterwards. Türk Traktör's S scores also remain above the threshold value in all years examined; strong scores approaching 2 in 2021–2023 confirm that the company is among the solid players in the sector in terms of operational profitability.

Tofaş and Otokar form a group that is generally healthy in terms of Springate but also exhibits distinct periodic weaknesses. Tofaş shows a relatively weak performance only in 2016 with a score slightly below the threshold value, but exceeds 0.862 in all other years, placing it in the region considered healthy by the model; this indicates that the company's short-term debt repayment capacity and operating profitability (Springate (1978) are generally adequate. For Otokar, the consistently high S scores in the 2016–2021 period indicate that the company had a strong operational structure during these years; conversely, the scores falling below the threshold after 2022 reveal a significant deterioration in short-term debt repayment capacity and profitability in the near term. Tümosan's S scores, on the other hand, indicate a volatile risk profile; only the scores for 2016, 2022, and 2023, which are in the healthy range, point to strong profitability and cash generation capacity in certain years, while scores below the threshold in other years suggest that the company's operational performance was sometimes insufficient relative to its short-term liabilities. The companies identified as most problematic by the

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Springate model are Karsan and Anadolu Isuzu. Karsan only exceeded the threshold in 2020, experiencing brief relief, but remained below 0.862 in all other years, placing it in the financial failure risk zone; this indicates chronic vulnerability in terms of cash generation and short-term debt repayment capacity, in addition to the risk of bankruptcy. Anadolu Isuzu, on the other hand, has failed to exceed the threshold in any year throughout the period, remaining in the risk zone continuously from 2016 to 2024; this profile indicates that the company is under persistent pressure in terms of operational profitability and short-term debt repayment capacity. Thus, similar to the Z-score, the S-score table frames Ford Otosan, Doğuş Otomotiv, and Türk Traktör as the strongest core in operational terms; Tofaş, Otokar, and Tümosan as the middle group to be monitored; and Karsan and Anadolu Isuzu as the fragile group with a high risk of financial failure.

6. CONCLUSION AND DISCUSSION

This study examined the financial failure risk of eight automotive and automotive manufacturing companies listed on the Istanbul Stock Exchange over the 2016–2024 period using the Altman Z-Score and Springate S-Score models and presented a comparative risk map across firms. The analysis is based exclusively on year-end (December 31) annual financial statements, rather than interim-period reports, to ensure consistency and comparability across firm-year observations.

The findings reveal that three main groups have emerged within the sector: financially strong core, medium risk, and vulnerable. Ford Otosan (FROTO), Doğuş Otomotiv (DOAS), and Türk Traktör (TTRAK) stand out as the relatively strongest companies throughout the period according to both models; Tofaş (TOASO), Tümosan (TMSN), and Otokar (OTKAR) belong to the middle group; Karsan (KARSN) and Anadolu Isuzu (ASUZU) can be classified as the group with the highest structural fragility.

Altman Z-Score results show that Ford Otosan and Doğuş Otomotiv were largely in the "safe zone" during the 2016–2024 period, while Türk Traktör was positioned between the upper band of the gray zone and the safe zone in most years. This table indicates that these three companies have been able to maintain a strong balance in terms of liquidity, profitability, and capital structure, even in the capital-intensive and volatile automotive sector. Tofaş, remaining in the gray zone for almost the entire period, is above the critical threshold in terms of bankruptcy risk, but has a more limited safety margin compared to the core strong companies. In Tümosan and Otokar, Z-Score values fluctuate between the danger and gray zones over the years; while some years yield quite strong scores, other years produce values close to the bankruptcy zone. The fact that the Z-Score for Karsan and Anadolu Isuzu remained below the 1.81 threshold for a long period reveals that these two companies carry a structurally high risk of financial failure according to the Altman model and have only been able to achieve partial improvements in limited periods.

Ford Otosan, Doğuş Otomotiv, and Türk Traktör scored above the threshold value of 0.862 in all years examined, indicating that these companies can comfortably cover their operating profit, pre-tax profit, and short-term liabilities. In this regard, the strong balance sheet structure revealed by the Z-Score is complemented by the strong cash generation and debt repayment capacity indicated by the S-Score. 's S-Score falling just below the threshold value only in 2016 and moving into the healthy zone in all subsequent years suggests that the company was relatively stable operationally throughout the analysis period and that the medium risk level indicated by the Z-Score in the gray zone was manageable thanks to its strong operating performance. In contrast, the S-Scores for Tümosan and Otokar, although above the threshold value in some years, produced low values indicating a significant weakening in short-term debt

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repayment capacity, particularly in Tümosan in 2018–2019 and in Otokar in 2022–2024. At Karsan and Anadolu Isuzu, Springate scores remained below the threshold value for almost the entire period, indicating that these two companies systematically exhibited a risky profile not only in terms of their balance sheet structure but also in terms of their operational cash generation and short-term debt repayment capacity.

When Altman Z-Score and Springate S-Score results are evaluated together, it is seen that the two models largely place the same companies in strong and weak groups, but produce different signals for specific companies and years, providing more detailed clues about the source of risk. For example, at Tofaş, although the Z-Score remained in the gray zone for a long time, the S-Score remained stable in the healthy zone after 2017, indicating that although the company did not fully transition to the "safe zone" in its balance sheet, it successfully managed its short-term debt with its operating profitability and cash generation capacity. At Tümosan, although the Z-Score rose to the gray zone in some years, the S-Score remained below the threshold value, indicating that despite a relative improvement at the balance sheet level, sufficient strengthening has not yet been achieved in operational profitability and short-term debt repayment capacity. At Otokar, the S-Score being healthy and the Z-Score mostly at the danger/gray threshold during the 2016–2021 period indicates that the operational side has provided a significant buffer for a long time despite the fragile balance sheet; conversely, the weakening of both the Z and S scores after 2022 shows that this buffer has also begun to erode. These findings are consistent with studies in the literature showing that the Altman and Springate models often produce parallel warnings, but sometimes produce different warnings, especially during periods of increased liquidity and profitability pressures (Türk & Kürklü, 2017; Şahin & Özkan, 2022; Yetik, 2024).

From a macroeconomic perspective, the analysis period coincides with a process of heightened financial fragility in the Turkish economy, including the 2018 currency shock, the 2020 pandemic impact, and high inflation and interest rate volatility after 2021. Nevertheless, Ford Otosan, Doğuş Otomotiv, and Türk Traktör generally remained in the safe zone according to both models, demonstrating that strong export performance, productivity gains, robust dealer and supply chain management, and effective financial risk management practices can limit the risk of financial failure. On the other hand, the persistent weakness in the Z and S scores of Karsan and Anadolu Isuzu indicates that factors such as more limited scale, volatile profitability, and high sensitivity to currency/financing shocks can accelerate the accumulation of risk at the firm level during macroeconomic fluctuations. The fluctuating scores observed in Tümosan and Otokar show that periodic declines in demand and profitability, in particular, can quickly translate into financial failure signals through early warning models, once again highlighting the critical importance of risk management and capital structure decisions in cyclical sectors such as the automotive industry.

The findings have various practical implications for managers and investors. First, rather than relying on a single score model to assess the risk of financial failure, companies should use complementary models such as the Z-Score and S-Score together, as this allows them to distinguish between structural risks on the balance sheet and operational risks on the income statement. For companies with a relatively strong Z-Score but a weak S-Score, strategies focused on profitability, cost management, and cash flow should be prioritized to increase short-term debt repayment capacity. Conversely, for companies with a strong S-Score but a Z-Score in the gray or danger zone, it would be meaningful to prioritize balance sheet restructuring policies aimed at capital increase, debt maturity extension, and currency risk reduction. From the perspective of investors and creditors, these scores enable pricing, collateral, and credit

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terms to be adjusted based on risk by categorizing companies into low, medium, and high risk groups.

In conclusion, this study presents a detailed financial risk map for the BIST automotive and automotive manufacturing sectors for the 2016–2024 period using the Altman Z-Score and Springate S-Score models, revealing which companies are more resilient to macroeconomic shocks and which are more vulnerable. However, since the analysis is based solely on two ratio-based models and annual financial statements, it serves as an early warning and descriptive risk measurement rather than making causal inferences about the reasons for financial failure. Future studies incorporating other financial failure models such as Ohlson and Zmijewski alongside Z and S scores, using panel data or dynamic panel methods, and including firm characteristics such as corporate governance, scale, export intensity, and technological innovation, will enable more in-depth results for both the automotive sector and similar capital-intensive sectors.

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