

Predicting Financial Distress in Companies Listed on The Indonesia Sharia Stock Index (ISSI): An Examination of The Zmiejewski, Springate, and Altman Models

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Abstract

Financial distress is critical financial condition in which a company experiences serious difficulties in meeting its financial obligations. This condition is marked by the company's inability to pay both short-term and long-term debts, as well as a declining trend in cash flow, which can lead to bankruptcy if not promptly addressed. The purpose of this study is to compare the predictive model Altman, Zmijewski, and Springate in order to determine the parameters of corporate financial trouble. 24 manufacturing firms included in the Indonesia Sharia Stock Index made up the sample. The Sample was determined by purpose sampling technique. Data analysis method used is binary logistic regression. This analysis technique was chosen for its ability to process binary data and predict the likelihood of financial distress occurring. The study's finding demonstrated that the prediction model was successful in identifying the financial difficulties of the business. There are significant variations in financial distress predictions between models. Among the models, the Zmijewski model has the highest accuracy and thus the best model performance. The Altman and Springate models also provide valuable contributions, but they are not as accurate as the the Zmijewski model. The Zmijewski model is designed to capture changes in a company's financial condition more sensitively. This makes it more capable of identifying early signs of financial distress before the situation deteriorates significantly.

Keywords: Financial Distress, Altman, Springate, Zmijewski Model

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1. INTRODUCTION

Companies are expected to ensure their long-term existence. To achieve this, a company must have a strong financial foundation to avoid the looming threat of financial distress. Financial distress that occurs reflects poor company performance. Companies must conduct financial performance evaluations to determine whether the company is in good health or not. The need for financial performance analysis and prediction is crucial, not only for the company but also for investors. This analysis can be useful in anticipating future financial difficulties.

Analyzing financial distress or financial distress through models that can serve as detectors involves analyzing financial performance. Its purpose is to assess whether a company is in a state of financial distress or not. If a company is in financial distress, it is highly likely to end up in bankruptcy. The potential

for bankruptcy is determined by the value calculated using predictive model formulas. Several analytical models have been developed to predict financial distress as an early sign of a company's bankruptcy.

The Altman model is an analytical model for predicting financial distress based on a company's financial ratios introduced by Altman in 1968. The formula used to measure a company's health originally included 22 financial ratios in multivariate discriminant analysis. Eventually, Altman focused on five ratios. In 1978, Springate did something similar to Altman. He attempted to analyze the financial distress condition, combining 19 popular financial ratios with a sample of 40 companies located in Canada. The model developed by Springate had an accuracy rate of 92.5%. Additionally, the Zmijewski model, also known as X-Score, developed by

Zmijewski in 1983, involved combining specific financial ratios and several different companies.

Although the Altman's Model was developed in 1986 and subsequently modified, (Siddiqui, 2012) suggests that the results of this predictive model are still highly relevant for contemporary use. Novietta and Minan (2017) stated that Altman modified the equation model to make it applicable to all types of companies, including manufacturing, non-manufacturing, and bond-issuing companies, not only in advanced countries like the United States, where Altman originally used it, but also in developing countries.

Gunathilaka (2014) in their research, questioned whether the Altman model could predict business failures in Greece. Companies listed on the Athens Exchange Companies were observed. The study resulted in the Altman model performing well in predicting company failures. Appiah (2011) applied the Altman model to analyze financial distress on the Ghana Stock Exchange. Odibi et al. (2015) found that the Altman model was suitable for companies listed under PN17 on the Kuala Lumpur Stock Exchange, now known as Bursa Malaysia.

Edi and Tania (2018) explained that the most accurate model for predicting financial distress is the Springate model. Furthermore, they stated that the determination coefficient of the Springate model is much higher compared to other models. Januri et al., (2017) also used other predictive models to analyze the financial conditions of companies, including the Zmijewski model. The explanation related to the application of this model to companies is that the use of the Zmiejewski model is not sensitive to industry classification. Results from the comparison of the Grover, Springate, and Zmijewski models used by Permana et al. (2017) to analyze financial distress in manufacturing companies explained that the Zmijewski model had a higher accuracy rate compared to other models. Various industries can be analyzed using these models (Gricee & Dugan, 2003). Studies that have been conducted show that these models can be applied very effectively, each having varying degrees of sensitivity to a company's failure.

Researchers will apply these models to manufacturing companies in Indonesia, specifically those listed on the Indonesia Sharia Stock Index (ISSI). Companies listed on the ISSI were selected because the stocks included in the ISSI tend to be volatile, as seen from the beta volatility levels of

individual stocks within the ISSI (Akbar et al., 2017). Therefore, the researchers will analyze the application of the Zmejewski, Springate, and Altman models in predicting financial distress for manufacturing companies listed on the Indonesia Sharia Stock Index (ISSI).

LITERATURE REVIEW

The research findings, as categorized by the researcher based on the predictive models used in this study, are as follows: Gunathilaka (2014) identified financial distress in Sri Lanka using the Altman and Springate models. He applied these models to 82 companies listed on the Colombo Stock Exchange from 2008 to 2012. The research showed that both the Altman and Springate models exhibited nearly similar predictive strength, but the Altman model had a higher discriminant strength. Pakdaman (2018) analyzed financial distress in companies by combining several models, including the Altman, Zmijewski, Springate, and Grover models on the Tehran Stock Exchange. His research found that the best model for identifying financial distress in companies was the Altman model. Syamni et al. (2018) explored the use of financial distress predictor models on 19 companies in the Coal Mining Industry in Indonesia with regard to their stock prices. The research provided evidence that the Ohlson and Modified Altman models were dominant in influencing stock prices. Furthermore, the study indicated that bankruptcy prediction models could be used to predict stock price movements and the financial performance of the coal industry in Indonesia. Pongsatat et al. (2004) conducted an analysis of predicting company bankruptcy by comparing the Ohlson and Altman models applied to both large and small companies in Thailand. The research concluded that there was no significant difference in predictive ability between companies with large assets and those with small assets.

Parvizi (2015) applied the Zavgren and Altman models to correct financial distress in companies listed on the Tehran Stock Exchange (TSE). The research found that these models effectively corrected financial distress in TSE-listed companies. Turk and Kurklu (2017) measured the level of financial distress in 166 companies across seven different sectors in the BIST Index. They analyzed financial stress levels using financial ratios based on the Altman and Springate models. The analysis showed that the Altman model indicated that 69% of the total companies experienced

financial problems, while the Springate model indicated that 59% of the total companies faced financial difficulties. Putera et al., (2016) in a study that sampled seven coal companies, found that the Springate model had better accuracy compared to the Altman and Ohlson models. Rachaprima et al., (2015) stated that three out of four predictive models had a very accurate level of analysis with a potential bankruptcy rate of 100%, namely the Springate, Zmijewski, and Grover models. On the other hand, the Ohlson model had an accuracy rate of 80%. Meiliawati dan Isharijadi (2017) compared the Springate and Altman models in detecting potential financial distress. The research results showed a significant difference between the Springate and Altman Z-Score models in predicting potential financial distress. Furthermore, the study also indicated that the Springate model was the most accurate in predicting financial distress. Imanzadeh et al., (2011) used the Springate and Zmijewski models to predict bankruptcy in two different industries, pharmaceutical and textile, on the Tehran Stock Exchange. The findings revealed that the Springate model was more conservative in predicting company bankruptcies compared to the Zmijewski model.

Gerritsen (2015) applied different bankruptcy prediction models, including the Altman, Ohlson, and Zmijewski models, to the professional football industry in the Netherlands for the seasons 2009/2010 to 2013/2014. The findings showed that the Zmijewski model outperformed the other predictive models. Avenhuis (2013) attempted to test the predictive strength of the Altman, Ohlson, and Zmijewski bankruptcy prediction models on both bankrupt and non-bankrupt companies in the Netherlands. The results indicated differences in the predictive abilities of these models. Meanwhile, the Zmijewski model exhibited a higher level of accuracy. Gunawan et al. (2017) assessed the accuracy levels of the Altman, Grover, and Zmijewski models in predicting financial distress. The Zmijewski model demonstrated the highest level of accuracy in predicting financial distress. Fanny (2017) conducted research on plantation companies listed on the Indonesia Stock Exchange (BEI) during the period 2012-2014. They explained that there were differences in predictive models among the Altman, Springate, and Zmijewski models in predicting financial distress. The study, with a sample of plantation companies listed on the BEI, found that the Zmijewski model had the highest

accuracy rate compared to other models, with an 82% accuracy rate. Gricee and Dugan (2003) applied the Ohlson and Zmijewski models to companies experiencing problems and those that were not, using data from Compustat's Industrial Annual Research File (CIAR) and Compustat's Industrial Annual file (CIA). The research findings indicated that the Zmijewski model had a higher accuracy rate of 98.2% compared to the Ohlson model, which had an accuracy rate of only 96.4%.

Financial distress is a condition of financial difficulty experienced by a company. The existence of such a condition is an early indication that the company may face bankruptcy. Ullah et al., (2021) state that financial distress is the inability of a company to meet its obligations (insolvency). Raza et al. (2020) explains that financial distress is a condition where the company's operating cash flow is no longer sufficient to make payments related to settling its current debt obligations. Therefore, corrective actions are needed to bring the company back to a better state. The bankruptcy process begins when a company is unable to repay its obligations to banks, suppliers, tax authorities, and employees. When the company's aggregate obligations exceed the nominal value of its assets, this leads to bankruptcy, where assets are used to partially pay the outstanding liabilities (McKee, 2003). Financial difficulties for a company are considered a continuous event - escalating over time without timely corrective measures, which will eventually lead to failure and the cessation of company activities. It can be said that as long as a company has cash flow greater than its obligations, the company will be able to repay its debts as well.

The Altman Model is an analytical model designed to predict financial distress based on a company's financial ratios introduced by Altman in 1968. Below is the revised equation of the model from its original version presented by Altman (Altman & Edith, 2006):

$$\text{Z - Score} = 0,717 X_1 + 0,847 X_2 + 3,107 X_3 + 0,420 X_4 + 0,998 X_5$$

The financial ratios found in the Altman model are:

X_1 : Working Capital to Total Assets

X_2 : Retained Earnings to Total Assets

X_3 : Earning Before Interest and Taxes to Total Assets

X_4 : Market Value of Equity to Book Value of Total Liability

X_5 : Sales to Total Assets

The model developed by Gordon L.V. Springate in 1978 is related to research aimed at finding a model that can be used to predict the potential or indications of bankruptcy. Springate identified four ratios that can be used to predict the potential bankruptcy of a company, with an accuracy rate of up to 92.5%. Below is the equation of the model proposed by Springate:

$$S - \text{Score} = 1,03 X_1 + 3,07 X_2 + 0,66 X_3 + 0,4 X_4$$

The financial ratios found in the Springate model are:

X_1 : Working Capital to Total Assets

X_2 : Earning Before Interest and Taxes to Total Assets

X_3 : Earning Before Taxes to Current Liability

X_4 : Sales to Total Assets

Zmijewski (1984) employs ratio analysis measuring the leverage, profitability, and liquidity of

a company to predict financial distress. Zmijewski utilized a sample of 40 bankrupt companies and 800 surviving companies. The model successfully developed by Zmijewski is as follows:

$$X - \text{Score} = -4,31 - 4,5 X_1 + 5,7 X_2 + 0,004 X_3$$

The financial ratios found in the Zmijewski model are:

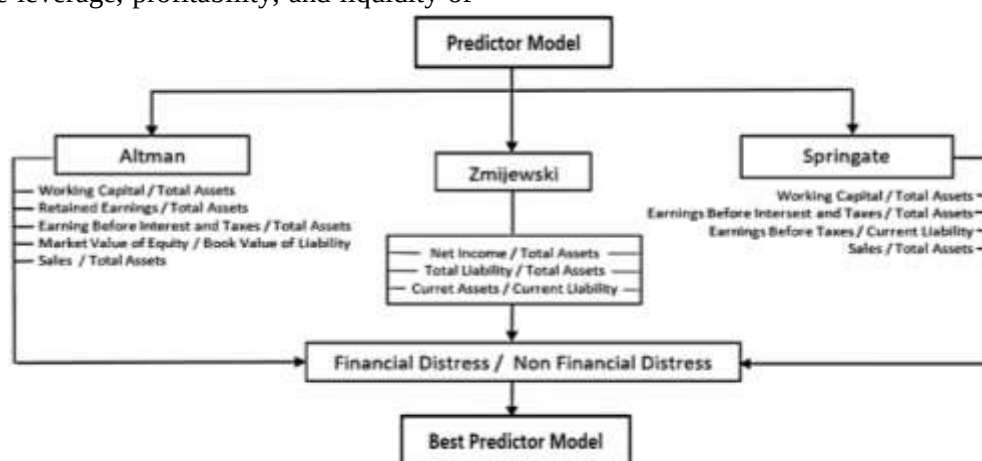
X_1 : Net Income to Total Assets

X_2 : Total Liability to Total Assets

X_3 : Current Assets to Current Liability

Conceptual Framework

The assessment of bankruptcy prediction can be conducted by understanding the process of an analysis. The researcher has formulated the conceptual framework for this study as follows:



Based on the analysis framework above, it can be explained how the financial ratios used in each model can predict financial distress or vice versa. Subsequently, identify the best predictive model among them.

2. METHODS

The data used in this research is secondary data in the form of financial reports of manufacturing companies listed on the Indeks Saham Syariah Indonesia (ISSI). The data collection technique employed is purposive sampling. The sampled companies in the research amount to 24, selected based on predetermined criteria from the initial pool of 574 companies listed on the Indeks Saham Syariah Indonesia (ISSI).

The steps to be taken in this analysis include calculating the financial ratios of companies according to the variables in the Altman, Zmijewski, and Springate models. Next is to calculate the index values for the Altman, Zmijewski, and Springate models.

Once completed, the subsequent step is to classify the company's condition according to the predetermined cut-off points. The cut-off points for each model are as follows:

a. Altman Model

Model Altman uses cut-off values of 1.23 and 2.90. The cut-off equation for the Altman model is as follows:

$$Z - \text{Score} > 2.90: \text{Safe Zone} \dots\dots\dots(2.1)$$

$$1.23 < Z - \text{Score} < 2.90: \text{Gray Zone} \dots\dots(2.2)$$

$$Z - \text{Score} < 1.23: \text{Distress Zone} \dots\dots\dots(2.3)$$

b. Springate Model

The Springate model has a cut-off value of 0.862. This means that if a company obtains an S-Score greater than 0.862, the company is classified as being in a non-financial distress condition. On the other hand, if a company obtains an S-Score below 0.862, the model predicts the company to be in a financial distress condition. The cut-off equation for the Springate model is as follows:

$S - Score < 0.862$: *Distress Zone* (2.4)

$S - Score > 0.862$: *Safe Zone* (2.5)

c. Zmijewski Model

The Zmijewski model establishes a cut-off value of 0. This value indicates that if a company has an X-Score above 0, the company is considered to be in a financial distress condition. Conversely, if a company has an X-Score below 0, the model predicts that the company is not in a financial distress condition. The cut-off equation for the Zmijewski model is as follows:

$X - Score > 0$: *Distress Zone*(2.6)

$X - Score < 0$: *Safe Zone* (2.7)

To calculate the accuracy rate and determine how accurately each model predicts, the accuracy rate indicates the percentage of correct predictions relative to the total sample. The accuracy rate for each model is calculated as follows:

$$\text{level of accuracy} = \frac{\text{Number of correct predictions}}{\text{Number of Sampels}} \times 100\% \dots\dots\dots(2.8)$$

In addition to the accuracy of each model, another consideration is the error rate, which is divided into two types: Error Type I and Type II. The error rate is calculated as follows:

$$\text{Error Type I} = \frac{\text{Number of Type I Errors}}{\text{Number of Sampels}} \times 100\% . (2.9)$$

$$\text{Error Type II} = \frac{\text{Number of Type II Errors}}{\text{Number of Sampels}} \times 100\% (2.10)$$

Model regresi logistik biner is used to analyze the relationship between one response variable and several predictor variables, where the response variable is qualitative and dichotomous. It takes a value of 1 to indicate the presence of a characteristic and 0 to indicate the absence of a characteristic.

3. RESULT AND DISCUSSION

Based on calculations using the Altman, Springate, and Zmijewski financial distress prediction models on manufacturing companies listed on the Indonesian Sharia Stock Index (ISSI) during the period of 2008-2017, there are differences in the outcomes for the number of companies detected as experiencing financial distress and those detected as non-financial distress. Below are the results of the prediction comparison using the Altman, Springate, and Zmijewski models:

Table 3.1

Comparison of prediction results

Abridgment Prediktor Model	Detection			Total
	Financial Distress	Grey Area	Non Financial Distress	
Springate	2	-	22	24
Zmijewski	1	-	23	24
Altman	1	9	14	24

Source: Data processing results, 2023.

From the table above, it is evident that in predicting financial distress, the Altman model predicts that 14 companies are detected as not experiencing financial distress, while nine other companies are in the Grey area. The Grey area represents a condition where the company is in between financial distress and non-financial distress. Meanwhile, one company is detected in a financial distress condition. In contrast, the Springate model results show that it detects 22 companies in a non-financial distress condition, with the remaining two companies not experiencing financial distress. Lastly, the Zmijewski model detects 23 companies not experiencing financial distress, while one other company has the potential to be in a financial distress condition.

Tabel 3.2. Comparison of company categories

No	Emiten	Model					
		Zmijewski Model		Springate Model		Altman Model	
		X-Score	Kriteria	S-Score	Kriteria	Z-Score	Kriteria
1	UNVR	-2.382	NFD	4.746	NFD	4.833	NFD
2	DVLA	-3.346	NFD	3.611	NFD	3.614	NFD
3	TSPC	-3.104	NFD	3.137	NFD	3.949	NFD
4	GDYR	-1.435	NFD	0.83	FD	2.029	GA
5	INDS	-2.288	NFD	2.111	NFD	3.022	NFD
6	SMSM	-2.906	NFD	4.536	NFD	3.562	NFD
7	BRAM	-2.864	NFD	2.757	NFD	2.383	GA
8	INTP	-4.189	NFD	7.542	NFD	4.525	NFD
9	JPFA	-1.236	NFD	2.82	NFD	2.945	NFD
10	LION	-3.572	NFD	4.901	NFD	3.828	NFD
11	NIKL	-1.123	NFD	1.338	NFD	2.423	GA
12	UNIC	-2.044	NFD	1.445	NFD	2.909	NFD
13	AUTO	-3.104	NFD	1.687	NFD	2.781	GA
14	KDSI	-1.208	NFD	1.434	NFD	2.811	GA
15	LMSH	-2.807	NFD	3.524	NFD	4.107	GA
16	MLIA	1.539	FD	1.52	NFD	1.612	GA
17	LMPI	-1.854	NFD	0.814	FD	1.963	NFD
18	ARNA	-2.413	NFD	2.627	NFD	2.659	GA
19	FASW	-0.393	NFD	1.563	NFD	1.142	FD**
20	INDF	-1.653	NFD	1.944	NFD	2.024	GA*
21	KAEF	-2.285	NFD	6.714	NFD	4.658	NFD***
22	KLBF	-3.856	NFD	12.814	NFD	5.857	NFD
23	TCID	-3.955	NFD	7.525	NFD	5.243	NFD
24	ULTJ	-3.251	NFD	6.293	NFD	3.999	NFD

*GA : Grey Area
 **FD : Financial Distress
 ***NFD : Non Financial Distress

Source: Data processing results, 2023.

Looking at the classification of companies in each model above, there are three companies with significant potential for financial distress: LMPI, GDYR, and MLIA. This is observed from the detection in each model, where these companies are in a condition of almost or detected financial distress. LMPI and GDYR are in the Grey area in the Altman model, while they are in a financial distress condition in the Springate model. On the other hand, Mulia Industrindo is in the Grey area in the Altman model, while in the Zmijewski model, the company is in a financial distress condition. This should be a cause for concern for each company to improve its performance.

Not stopping there, the researchers attempted to further substantiate the accuracy levels of the models used to predict whether companies are in a state of financial distress or not. A retesting was conducted using Binary Logistic regression techniques with dummy variables, where the dummy variable represents the categories of Financial Distress and Non-Financial Distress. The following are the results of Binary Logistic regression testing for each prediction model:

Table 3.3. Model Summary

	Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
Altman	1	22.393 ^a	0.243	0.783
Zmijewski	1	.000 ^a	0.344	1
Springate	1	28.312 ^a	0.433	0.873

Source: Data processing results, 2023.

The test results produced a model summary, which was used to assess the independent capability of predictive models in explaining their dependents, using the Nagelkerke R Square or, in linear regression, referred to as the coefficient of determination (R^2). This value is also known as the Pseudo R-Square.

The Pseudo R-Square for the Altman model is obtained as 0.783, indicating that the Altman model can explain the financial distress condition by 78.30%. Meanwhile, the Springate model has a Pseudo R-Square value of 0.873, meaning that the Springate model can explain the financial distress condition by 87.30%. Finally, the Zmijewski model yields a Pseudo R-Square value of 1.000, signifying that the model can exceptionally well explain the financial distress condition, with a capability of 100%. Among the tested predictive models, the Zmijewski model demonstrates superior capability compared to the Altman and Springate models.

In measuring the accuracy of the models, researchers also examined values in the classification plot from the binary logistic regression test. The Classification Plot reflects how well the model can predict from the samples used. The Classification Plot table can be seen below:

Table 3.4.
Classification

Models			Observed	Predicted		Percentage Correct
				Y		
				Financial Distress	Non Financial Distress	
Altman	Step 1	Y	Financial Distress	7	4	63.6
			Non Financial Distress	4	225	98.3
			Overall Percentage			96.7
Zmijewski	Y	Y	Financial Distress	13	0	100
		Non Financial Distress	0	227	100	
		Overall Percentage			100	
Springate	Y		Financial Distress	25	1	96
			Non Financial Distress	1	213	98.3
			Overall Percentage			99.2
a. The cut value is 0.500						

a. The cut value is 0.500

Source: Data processing results, 2023.

From the table above, it can be shown that the models used have nearly equal capabilities. The Altman model has an overall percentage of 96.7, meaning the model can correctly predict 96.70% of the conditions. The Springate model, on the other hand, can predict correctly with a percentage of 99.20%, and finally, the Zmijewski model has an overall percentage of 100.0, indicating that the Zmijewski model predicts correctly with 100% accuracy.

Table 3.5

Predictor Model Capabilities

Model	Level of Accuracy	Pseudo R Square	Classification Plot	Mean
Springate	91.6%	87.3%	99.2%	92.7%
Zmijewski	95.8%	100%	100%	98.6%
Altman	58.3%	78.3%	96.7%	77.7%

Source: Data processing results, 2023.

When comparing the results between manual accuracy calculations and binary logistic regression testing, similarities and differences in the outcomes can be observed. The accuracy values for the Zmijewski model, whether calculated manually (Accuracy Rate) or through binary logistic regression (Pseudo R Square and Classification Plot), consistently show the highest accuracy among the models, averaging at 98.60%. Meanwhile, the Springate model has a lower average correct prediction ability at 92.7%, compared to the Zmijewski model. Lastly, the Altman model has an average correct prediction ability of 77.7%, which is smaller than both the Zmijewski and Springate models. The results indicate a significant gap between the Altman model and the Springate and Zmijewski models.

4. CONCLUSION AND RECOMMENDATION

In conclusion, it is important to note that financial difficulties are a common phenomenon that companies may face, regardless of their size, in various developed and developing countries. Predicting financial distress in companies is a significant topic that has attracted the attention of many researchers, academics, and professionals who have long been interested in understanding business failures. There are many direct and indirect reasons that lead companies to experience financial distress, ultimately leading to bankruptcy.

In identifying the predictive abilities among the Altman, Springate, and Zmijewski models in manufacturing companies, it can be concluded that the Altman, Springate, and Zmijewski models are capable of predicting the financial distress conditions of manufacturing companies in the Indonesian Sharia Stock Index (ISSI), with varying accuracy levels. The predictive model with the highest accuracy is the Zmijewski model, followed sequentially by the Springate and Altman models. Additionally, the type error values for the Zmijewski model are relatively smaller, making it considered more suitable for predicting the financial distress conditions of companies.

The research findings indicate that the Zmijewski model demonstrates the highest accuracy in predicting financial distress for companies. Therefore, it is recommended to consider using this model as a primary tool for identifying financial risks and managing corporate performance. The findings from this study can serve as a basis for developing proactive policies and business strategies to address financial

distress challenges and optimize resource allocation, thereby reducing risks that could disrupt operational continuity of the company.

5. REFERENCES

- Akbar, A., Hermawan, A., & Beik, I. S. (2017). Analisis stabilitas kinerja saham syariah pada indeks saham syariah indonesia (issi) | Perpustakaan Sekolah Bisnis. *Jurnal Ekonomi Islam* *Republika*, *IPB*. <https://librarysb.ipb.ac.id/opac/detail-opac?id=13859>
- Appiah, K. O. (2011). Corporate Failure Prediction: Some Empirical Evidence From Listed Firms in Ghana. *China-USA Business Review*, *10*, 32–41.
- Avenhuis, J. O. (2013). Testing the generalizability of the bankruptcy prediction models of Altman, Ohlson and Zmijewski for Dutch listed and large non-listed firms. *Journal of Business Administration, Publisher: University of Twente*, 38–39.
- Edi, E., & Tania, M. (2018). Ketepatan Model Altman, Springate, Zmijewski, Dan Grover Dalam Memprediksi Financial Distress. *Jurnal Reviu Akuntansi Dan Keuangan*, *8*(1), 79. <https://doi.org/10.22219/jrak.v8i1.28>
- Fanny, T. A. (2017). Analisis Perbandingan Model Prediksi Financial Distress pada Sub Sektor Perkebunan (Studi Empiris di Bursa Efek Indonesia). *6*, 1–15.
- Gerritsen, P. (2015). Accuracy Rate of Bankruptcy Prediction Models for the Dutch Professional Football Industry. *September*, 1–63.
- Gricee, J. S., & Dugan, M. T. (2003). Re-Estimations of The Zmijewski And Ohlson Bankruptcy Prediction Models. *Advances in Accounting*, *20*, 77–93. [https://doi.org/10.1016/S0882-6110\(03\)20004-3](https://doi.org/10.1016/S0882-6110(03)20004-3)
- Gunathilaka, C. (2014). Financial Distress Prediction : A Comparative Study of Solvency Test and Z - Score Models with Reference to Sri Lanka. *The IUP Journal of Financial Risk Management*, *11*(3), 39–51.
- Gunawan, B., Pamungkas, R., & Susilawati, D. (2017). Perbandingan Prediksi Financial Distress Menggunakan Model Altman, Grover dan Zmijewski. *Jurnal Akuntansi Dan Investasi*, *18*(1), 119–127. <https://doi.org/10.18196/jai.18164>
- Imanzadeh, P., Maran-Jouri, M., & Sepehri, P. (2011). A study of the application of springate and zmijewski bankruptcy prediction models in firms accepted in tehran stock exchange. *Australian Journal of Basic and Applied Sciences*, *5*(11), 1546–1550.
- Januri, Sari, E. N., & Diyanti, A. (2017). The Analysis of the Bankruptcy Potential Comparative by Altman Z-Score, Springate And Zmijewski Methods at Cement Companies Listed In Indonesia Stock Exchange. *IOSR Journal of Business and Management*, *11*(10), 80–87. <https://doi.org/10.9790/487X-1910068087>
- McKee, T. E. (2003). Rough sets bankruptcy prediction models versus auditor signalling rates. *Journal of Forecasting*, *22*(8), 569–586. <https://doi.org/10.1002/FOR.875>
- Meiliawati, A., & Isharijadi, I. (2017). Analisis Perbandingan Model Springate Dan Altman Z Score Terhadap Potensi Financial Distress (Studi Kasus Pada Perusahaan Sektor Kosmetik Yang Terdaftar Di Bursa Efek Indonesia). *Assets: Jurnal Akuntansi Dan Pendidikan*, *5*(1), 15. <https://doi.org/10.25273/jap.v5i1.1183>
- Muhammad Reza Rachaprima, Tanjung, A. R., & Idrus, R. (2015). Analisis Komparatif Prediksi Kebangkrutan Denganmodel Ohlson, Springate, Zmijewski, Dan Grover Pada Perusahaan Konstruksi Dan Bangunan Yang Terdaftar Di Bursa Efek Indonesia. *Jurnal Online Mahasiswa*, *2*(2). <http://koranjakarta.com/?pg=instagr>
- Odibi, I., Basit, A., & Hassan, Z. (2015). Bankruptcy Prediction Using Altman Z-Score Model: a Case of Public Listed Manufacturing Companies in Malaysia. *International Journal of Accounting and Business Management*, *3*(2), 178–186. <https://doi.org/10.24924/ijabm/2015.11/v3.iss2/178.186>
- Pakdaman, H. (2018). Investigating the ability of Altman and Springate and Zmijewski and grover bankruptcy prediction models in Tehran Stock Exchange. *Espacios*, *39*(14).
- Parvizi, B. (2015). A Study of Bankruptcy prediction accuracy of Altman Adjusted and Zavgren models in firms accepted in Tehran stock exchange. (based on Altman adjusted model by Kordestani and colleagues). *World Essay Journal*. https://www.academia.edu/74509629/A_Study_of_Bankruptcy_prediction_accuracy_of_Altman_Adjusted_and_Zavgren_models_in_firms_accepted_in_Tehran_stock_exchange_based_on_Altman_adjusted_model_by_Kordestani_and_colleagues
- Permana, R. K., Ahmar, N., & Djadang, S. (2017). Prediksi Financial Distress Pada Perusahaan Manufaktur Di Bursa Efek Indonesia. *Esensi: Jurnal Bisnis Dan Manajemen*, *7*(2), 149–166. <https://doi.org/10.15408/ess.v7i2.4797>

- Pongsatat, S., Ramage, J., & Lawrence, H. J. (2004). Bankruptcy Prediction for Large and Small Firms in Asia: A Comparison of Ohlson and Altman. *Journal of Accounting and Corporate Governance*, 1(2), 1–13. <https://doi.org/10.30139/JACG.200412.0001>
- Putera, F. Z. Z. A., Swandari, F., & Dewi, D. M. (2016). Perbandingan Prediksi Financial Distress Dengan Menggunakan Model Altman, Springate Dan Ohlson. *Jurnal Wawasan Manajemen*, 4(3), 217–230.
- Raza, H., Muhammad, S., Gillani, A. H., Qureshi, M. I., Ramakrishnan, S., Afraz, S. M., & Gillani, H. (2020). Non-systematic Review of Financial Sustainability and Financial Distress. *Article in International Journal of Psychosocial Rehabilitation*, 24(6), 885–900. <https://doi.org/10.37200/IJPR/V24I6/PR260085>
- Siddiqui, S. A. (2012). Business Bankruptcy Prediction Models: A Significant Study of the Altman's Z-Score Model. *SSRN Electronic Journal*. <https://doi.org/10.2139/SSRN.2128475>
- Syamni, G., Majid, M. S. A., & Siregar, W. V. (2018). Bankruptcy Prediction Models and Stock Prices of the Coal Mining Industry in Indonesia. *Etikonomi*, 17(1), 57–68. <https://doi.org/10.15408/etk.v17i1.6559>
- Turk, Z., & Kurklu, E. (2017). Financial Failure Estimate in Bist Companies With Altman (Z-Score) and Springate (S-Score) Models. *Journal of Economics and Administrative Sciences*, 1(1), 1–14.
- Ullah, H., Wang, Z., ABBAS, M. G., Zhang, F., Shahzad, U., & Mahmood, M. R. (2021). Association of Financial Distress and Predicted Bankruptcy: The Case of Pakistani Banking Sector. *The Journal of Asian Finance, Economics and Business*, 8(1), 573–585. <https://doi.org/10.13106/JAFEB.2021.VOL8.N01.573>