



Comparative Analysis of Altman and Grover's Methods in Predicting Bankruptcy Using the McNemar Test (Case Study: Vehicle Insurance Company in Indonesia)

Roy Donald Pangeran Siahaan^{1*}, Muhammad Rifan Marsa Rizqullah²

^{1,2}*Undergraduate Program in Mathematics, Faculty of Natural Science and Mathematics, Padjadjaran University, Sumedang,
West Java, Indonesia*

**Corresponding author email: roy21001@mail.unpad.ac.id*

Abstract

Vehicle insurance is an important component of automotive financing and consumer protection, which includes various forms of protection that protect the vehicle and its owner. Predicting the bankruptcy of a vehicle insurance company is also very important for vehicle insurance companies to be able to identify potential financial problems as early as possible and take the necessary corrective actions. The Altman and Grover model can be a way to analyze bankruptcy in company. In this study, PT. Asuransi Astra Buana, PT. Allianz Utama Indonesia, PT. Sinar Mas Insurance, and PT. BCA Insurance are used as the analyzed company. The McNemar Test conducted in this study shows that the two methods do not have significant differences in result, so the two methods will relatively have same results.

Keywords: Bankruptcy prediction, Altman Z-score, Grover method, McNemar test, vehicle insurance.

1. Introduction

The insurance industry is one of the important pillars in the Indonesian economic system. One important segment in the insurance industry is vehicle insurance, which provides protection for vehicle owners against the risk of loss due to accidents, theft, or damage. However, there is still a possibility that a vehicle insurance company faces bankruptcy, which can be caused by various factors such as poor management, high claims, or unstable economic conditions.

Bankruptcy prediction is crucial for vehicle insurers to identify potential financial problems as early as possible and take the necessary corrective action. There are several bankruptcy prediction models that have been developed by researchers, including the Altman model and the Grover model.

The Altman model, which was first introduced in 1968, is one of the most widely used bankruptcy prediction models. This model uses discrimination analysis to combine multiple financial ratios into a single score that can be used to predict the likelihood of a company's bankruptcy. On the other hand, the Grover model is a development of the Altman model which is designed specifically for companies in the service industry, including insurance companies.

Of course, the results of the two models do not necessarily give the same results, differences in results between the two models can of course occur. The difference in the results of the two models can be tested with one of the existing statistical tests, namely the McNemar Test. With this test, it can be tested whether there is a significant difference or not from the results of the two models.

The study aims to test whether the two models give similar results or give different results. By comparing the performance of the two models, it is hoped that insight can be obtained on which model is more suitable to be applied to the vehicle insurance industry in Indonesia. The results of this study can contribute to practitioners and academics in understanding and applying the right bankruptcy prediction model for vehicle insurance companies.

Table 1: Research Gap or Content Analysis

Author	Title	Method	Object	Statistical Test
Darmawan, Tubaka (2021)	Analisis Prediksi Kebangkrutan PT. Krakatau Steel (Persero) dengan Menggunakan Model Altman Z-Score	Altman Z-Score	Steel Industry	No
Sumolang, Mangindaan, Keles (2021)	Analisis Prediksi Kebangkrutan Perusahaan Properti Yang Terdaftar di BEI Dengan Model Altman Z-Score	Altman Z-Score	Property Industry	No
Putri, Nurulrahmatia, Muniarty (2024)	Analisis Perbandingan Prediksi Kebangkrutan Model Altman dan Springate Pada Perusahaan Sub Sektor Konstruksi Bangunan	Altman Z-Score, Springate Model	Building Industry	No
Mukhtaram, Suharti, Yudhawati, Kusumah (2023)	Analisis Prediksi Kebangkrutan (<i>Financial Distress</i>) dengan Menggunakan Metode Altman Z-Score dan Metode Grover (Pada Perusahaan Retail yang Terdaftar di Bursa Efek Indonesia Tahun 2017-2019)	Altman Z-Score, Grover Method	Retail Industry	No
Mukhtaram, Suharti, Yudhawati, Kusumah (2021)	Analisis Prediksi Tingkat Kebangkrutan Perusahaan dengan Menggunakan Metode Grover dan Altman Z-Score pada Perusahaan Rokok yang Terdaftar di BEI	Altman Z-Score, Grover Method	Manufacture Industry	No
Siahaan, Rizqullah (2024)	Analisis Metode Altman dan Grover dalam Prediksi Kebangkrutan pada Perusahaan Asuransi Kendaraan di Indonesia	Altman Z-Score, Grover Method	Insurance Industry	Yes (McNemar's Test)

2. Literature Review

2.1. Vehicle Insurance

Vehicle insurance is an important component of automotive financing and consumer protection, which includes various forms of protection that protect the vehicle and its owner. The importance of vehicle insurance is not only

limited to asset protection; This insurance also includes aspects of life insurance that can ease the financial burden of the heirs if the policy holder dies.

2.2. Bankruptcy

Referring to Law Number 37 of 2004 concerning Bankruptcy and Postponement of Debt Payment Obligations, bankruptcy is the general confiscation of all assets of bankrupt debtors, the management and settlement of which is carried out by curators under the supervision of supervisory judges. The definition of insolvency that causes bankruptcy is the debtor's inability to pay debts. From this, in some cases, a company does not have to be bankrupt to be declared bankrupt. More than that, the Bankruptcy and Suspension of Debt Payment Obligations Law, known as PKPU (Penundaan Kewajiban Pembayaran Utang), provides debtors to prepare proposals known as "Peace Plans" to their creditors (Simanjuntak, 2023). Bankruptcy and PKPU applications can be submitted by creditors or debtors themselves. To be declared bankrupt or PKPU, the debtor must be proven to have at least two creditors and at least one debt has matured and can be repaid (Warsito, 2024).

2.3. McNemar's Test

McNemar's Test is a statistical test used to test hypotheses: "Whether two paired samples come from or represent two different populations." (Heryana, 2020). This test was invented and developed in 1947 by McNemar. The McNemar test is often used to analyze binomial data paired with a 2 x 2 contingency table (Smith & Ruxton, 2020). The assumption used in this test is that each subject (or pair of corresponding subjects) produces two values as paired variables. In addition, the value of each subject must be dichotomous and mutually exclusive. A compact model of the McNemar test in the form of a 2 x 2 table can be presented as follows

Table 2: McNemar Test Model

		Condition 2		Line Summing
		Category 1 Response	Category 2 Response	
Condition 1	Category 1 Response	<i>a</i>	<i>b</i>	$a + b = n_1$
	Category 2 Response	<i>c</i>	<i>d</i>	$c + d = n_2$
	Column Summing	$a + c$	$b + d$	$n = n_1 + n_2$

The McNemar test was carried out with the following calculations:

$$X^2 = \frac{(|b - c| - 1)^2}{b + c} \quad (1)$$

Where X^2 is the McNemar test statistics, b and c are in accordance with the McNemar Test Model table. This test hypothesis is as follows.

H_0 : There was no significant change between the two paired observations.

H_1 : There was a significant change between the two paired observations.

Reject H_0 if the test statistic is greater than the critical value or the p-value is less than α .

3. Materials and Methods

3.1. Materials

The data used in this study are five data from vehicle insurance companies, namely PT. Asuransi Astra Buana (Astra Insurance), PT. Allianz Utama Indonesia, PT. Sinar Mas Insurance, PT. Tokio Marine Indonesia, and PT. BCA Insurance.

3.2. Methods

The method used in this study is a quantitative method with the following steps:

- Data collection from financial statements.
- Calculate each model using Python and Microsoft Excel.
- Processing results and conclusions.

3.2.1. Altman Model

Altman's model was originally formed in 1968 using 66 American companies as a sample, of which 33 companies went bankrupt, and 33 did not. The Altman *Z-score* model with the function *Z* is noted as follows:

$$Z = 1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + 0.999X_5$$

with,

- X_1 : Working capital/Total assets
- X_2 : Retained earnings/Total assets
- X_3 : EBIT (Operating Income)/Total assets
- X_4 : Market value of equity/ Book value of total liabilities
- X_5 : Sales/Total Assets
- Z : Z-Score

Z-score can be categorized into three categories to classify the indications that *Z-score* is given. Where, it can be classified as follows:

1. $Z > 2.99$: Safe, the company is in the safe zone and is not at risk of bankruptcy in the short term.
2. $1.81 < Z < 2.99$: *Grey Zone*, there is a risk of the company going bankrupt but it is uncertain.
3. $Z < 1.81$: High risk, the company is at high risk of going bankrupt.

3.2.2. Model Grover

The Grover model is a model that designed and developed from the Altman *Z-score* by Jeffrey S. Grover using thirteen new ratios that produce the following functions:

$$G = 1.65X_1 + 3.4X_2 - 0.016X_3 + 0.057$$

with

- X_1 : Working Capital/Total Assets
- X_2 : Earnings Before Interest and Taxes/Total Assets
- X_3 : Return on assets
- G : Grover Values

The results of the grover values obtained can be classified as follows (Saragih, 2019):

1. $G \leq -0.02$: The company is at risk of bankruptcy
2. $G \geq 0.01$: The company is not at risk of bankruptcy

3.3. Data

The following is a data table containing the variables used in this study. This data is obtained from the financial statements of each company at the end of 2023, and is processed into the following table:

Table 3: Variables used (IDR)

	PT. Astra Buana Insurance	PT. Allianz Utama Indonesia	PT. Sinar Mas Insurance	PT. BCA Insurance
Working capital	7,751,873,212,000,000.00	890,717,000,000.00	3,364,990,000,000.00	2,001,240,000,000.00
Retained earnings	7,644,887,524,000,000.00	757,000,000,000.00	4,672,383,000,000.00	998,278,000,000.00
Market value of equity	7,751,873,212,000,000.00	834,909,000,000.00	4,404,219,000,000.00	1,200,529,000,000.00
Sales	6,781,857,030,000,000.00	803,522,000,000.00	9,568,731,000,000.00	1,028,417,000,000.00
Book value of total liabilities	10,626,007,747,000,000.00	1,165,991,000,000.00	6,747,077,000,000.00	1,702,022,000,000.00
Earnings Before Interest and Taxes	1,564,878,157,000,000.00	442,021,000,000.00	697,805,000,000.00	157,213,000,000.00
Total Assets	18,377,880,959,000,000.00	2,056,708,000,000.00	11,151,296,000,000.00	2,902,551,000,000.00
Return on Assets	0.0763	0.0405	0.0554	0.0469

4. Results and Discussion

4.1. Results of Analysis on Insurance Companies

After using the Altman Z-Score and Grover methods, the following calculation results were obtained:

Table 4: Results of the calculation of the Altman Z-Score and Grover method

	Altman Z-Score	Grover
PT. Astra Buana Insurance	2.17590211776887	1.04126694877827
PT. Allianz Utama Indonesia	2.56413299664654	1.50164926631101
PT. Sinar Mas Insurance	2.40408935405740	0.76677274670367
PT. BCA Insurance	2.26478888903538	1.37804211975245

From these results, it can be seen that for the classification based on Altman Z-Score, all companies are in the *Grey Zone*, and based on the Grover *G-Score* classification, it is found that all companies are in good condition.

Table 5: Altman Z-Score and Grover Classification of each company

	Altman Z-Score	Grover
PT. Astra Buana Insurance	<i>Grey Zone</i>	Good
PT. Allianz Utama Indonesia	<i>Grey Zone</i>	Good
PT. Sinar Mas Insurance	<i>Grey Zone</i>	Good
PT. BCA Insurance	<i>Grey Zone</i>	Good

4.2. McNemar Statistical Test Results

After each company is classified, the McNemar Test will be carried out to test whether there is a significant difference between the Altman *Z-Score* method and the Grover Method, where for the classification of the Altman *Z-Score* Method, it will be given a grade of 1 if it includes the *Grey Zone* and 0 if the company is safe or good, as well as for the Grover Method, it will be given a grade of 1 if the company is not good. and 0 if the company is good. So the following table is obtained.

Table 5: Altman Z-Score

		Grover		Line Summing
		Insecure	Safe	
Altman Z-Score	<i>Grey Zone</i>	0	4	4
	Safe	0	0	0
	Column Summing	0	4	4

Then we get that $b = 4$ and $c = 0$, and the McNemar Test can be calculated as follows:

$$X^2 = \frac{(|4 - 0| - 1)^2}{4 + 0} = \frac{(|4| - 1)^2}{4} = \frac{(4 - 1)^2}{4} = \frac{3^2}{4} = \frac{9}{4} X^2 = 2.25$$

With the degree of freedom equals to 1 and $\alpha = 0.05$, the value of Chi Squared is obtained, which is $\chi^2 = 3.841$. Since the test statistics are smaller than the critical value, H_0 is accepted, which means that there is no significant difference between Altman and Grover's methods.

5. Conclusion

Based on the results obtained, it can be seen that based on the Altman Z-Score, it is obtained for all companies in the *Grey Zone*, which means that the company has some risks but cannot be certain for its bankruptcy. As for Grover G-Score, all companies have a value greater than 0.01, which means that the company is in good condition and there is no risk of bankruptcy. From the results of Z-Score and Grover, it is recommended to choose Allianz as insurance because it has the largest Altman Z-Score and Grover G-Score, which indicates that PT Allianz Utama Indonesia is the furthest from bankruptcy. Based on the results of the McNemar Test, it can be concluded that the Altman and Grover methods do not have significant differences in results for vehicle insurance companies, where, the two models give results that are not much different from each other. However, further research is needed to determine which model is better between the two models.

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