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Empirical Analysis of the Relationship Between Altman's Z-Score and Stock Performance Based on Airline Companies Listed in the United States

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Abstract: This research looks at any relevance between Altman's Z-score and the stock market performance of airline companies in the United States (US). Nearly a thousand pieces of data on various aspects of operation and financial status from 81 airline companies in the US are available. Additionally, stock return is used as an indicator of firm stock performance in this paper. In order to satisfy the purpose of determining the relationship between Z-score and stock performance as well as what may be inferred from high stock returns with regard to Z-score, two different regression processes are carried out. The first regression tests the relationship between Z-score and stock return, while the second regression examines whether there is a difference in Z-scores between well-performing airline companies and poorly performing ones using dummy variables. The results reveal that there is a significant positive correlation between the Z-scores of US airline companies and their stock performance; besides, high stock returns potentially imply relatively high Z-scores and vice versa. Therefore, one of the crucial steps that US airline companies must make is to strengthen their balance sheets in order to draw investors to make investments in their businesses.

Keywords: Z-score; US airline companies; Stock performance

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1. Introduction

The United States (US) airline industry has always been an industry with high concentration of assets and risks. The industry is highly vulnerable to changes in the economic environment, including oil prices, labor costs, and the state of economy [1,2]. Additionally, it is easily affected by non-human factors, such as weather condition, natural disasters, terrorist attacks, *etc*. [3]. In the past 20 years, the US airline industry has suffered from the 9/11 terrorist attacks, the overall economic downturn in the United States, and the rise in global oil prices [4]. This industry, which is extremely sensitive to external events, has inevitably suffered a huge blow, and almost every airline company has been affected to some extent. As a result, airline bankruptcies and mergers (acquisitions) have become increasingly common in the past decade [5].

Considering that the airline industry has a high asset density, studying the relationship between the operating conditions of the companies and the performance of their stock market may provide some insights into how to effectively reduce the negative impact of external factors on the performance of the market or to attract investors.

Based on the purpose of this research, this paper selects 81 airlines either from local or abroad but registered in the US. The data samples of each company's operating conditions at different time periods,

with a total time span between 1990 and 2013, are collected and analyzed using Altman's Z-score model to explore two aspects: whether there is a correlation between Z-score and the performance of the stock market and whether there is a significant difference between the Z-scores for companies with poor market performance and those for companies with better stock return. Based on these two discussions, this paper attempts to determine how to attract investors, *i.e*., whether it is necessary for airline companies to strengthen their balance sheets in order to ensure better stock market performance.

2. Literature review

In 1968, Edward Altman introduced a bankruptcy predictor that is now widely recognized. This predictor is a statistical model that combines five financial ratios to produce a product called a Z-score [6]. It turns out that this model is a reliable instrument for predicting the failure of various business entities. He devised this score as a quantitative measure of bankruptcy risk of firms for investors. According to this theory, a Z-score can be calculated for all non-financial companies, in which the lower the score, the greater the risk of the firm falling into financial distress [7].

Later, Altman suggested the use of a slightly different model when evaluating the financial status of a service company [8,9]. As early as the 1980s, Altman's model has been used in air transport to predict carrier failures, where it successfully predicted the bankruptcy of both Braniff and Continental [10].

3. Stock price and Z-score

In the debate of the relationship between share price and Z-score, Sukmawai *et al*. believe that the Z scoring method has no significant impact on stock prices [11]. Besides, Afrin also supported this conclusion in 2017 [12]. However, Apergis *et al*. have suggested a significant relationship between these two entities, in which the higher the risk of bankruptcy, the lower the share price, and vice versa. They claimed that this is due to holding investors' careful monitoring of companies' bankruptcy level with Z score each time an economic analysis is performed [13]. This conclusion has received support from Issabella, where she found that Altman's Z-score has a significant positive correlation with stocks return, but systematic risk does not add any impact on the latter [14].

Another supporter of the hypothesis that Z-score would have an impact on stock price is Morgan Stanley's strategy analyst, Graham Secker [15], who have ranked European companies with Z-scores. According to Secker, companies with weak balance sheets are considered by lenders to be at higher risk and face higher capital costs, thus causing their share prices to be lower than their peers.

4. Basic information regarding the airline industry

The airline industry is a highly competitive industry worldwide, not only in the US market and other markets in developed countries, but also in those emerging economies, such as India [16] and United Arab Emirates (UAE). This results in a lower margin, which is a typical characteristic of airline companies.

An important characteristic of airline companies is that they operate based on the significant level of fixed costs, derived from the purchases, leases, and maintenance of their aircrafts. In 1999, Behn and Riley pointed out that this specific characteristic limits the validity of past information. Besides that, other important characteristics must not be overlooked; for example, airline companies operate in strong business cycle caused by seasonality, and their profit is inversely correlated with energy prices [17].

With regard to the analysis of the financial status of airline companies, Schefczyk has pointed out the difficulties caused by the different taxation and accounting policies when analyzing several multinational airline corporations [18]. In 2004, Scheraga discovered a strong post 9/11 environment effect on airline companies and asserted that companies with relatively higher operating efficiency does not suggest higher financial mobility [19].

5. Relationship between Z-scores and stock returns

5.1. Data and method

In 1968, Altman came up with the original Z-score model, which can be used to predict bankruptcy. The model is as follows:

$$Z = 0.012X_1 + 0.014X_2 + 0.033X_3 + 0.006X_4 + 0.999X_5 \quad (1)$$

where *X1* = working capital/total assets; *X2* = retained earnings/total assets; *X3* = earnings before interest and taxes/total assets; *X4* = market value of equity/book value of total liabilities; and *X5* = sales/total assets. Before 1980s, the original model successfully predicted bankruptcy in the airline industry. However, due to the substantial increase in the use of lease to finance assets in recent years, the use of off-balance sheet leverage through operating lease will underestimate the assets generating the revenues [20], thereby exaggerating the X_5 variable in the model, which can in turn affect the effectiveness of the model to a certain extent. In view of that, Altman came up with a slightly different model, which can be used to assess the financial condition of service firms. For these reasons, the developed model is used in this paper. The model takes the following form (X_1, X_2, X_3, and X_4 are defined in the same way as the original formula. However, the data are in percentage form):

$$Z = 6.56X_1 + 3.26X_2 + 6.72X_3 + 1.05X_4 \quad (2)$$

First, we calculated the Z-scores. The data for Capital (WACP), Total Asset (AT), Retain Earnings (RE), Earning Before Interest Tax (EBIT), Market Value (MKVALT), and Total Liabilities (LT) were taken directly from Bloomberg. However, the market value data of some companies were incomplete or missing; thus, the sample size was greatly reduced. In order to ensure a more convincing result, we used as many data as we can to conduct the regression tests. The data PRCC (Price Close – Annual), CSHO (Common Shares Outstanding) and PSTK (Preferred/Preference Stock (Capital) – Total) were taken to calculate the market value using the following formula:

$$\text{MV= PRCC* CSHO+ PSTK} \quad (3)$$

Following the steps, we calculated the Z-scores for different companies in different years. A total of 840 results were obtained.

Second, we calculated the stock return by applying the following formula:

$$R_t = Ln\left(\frac{P_t}{P_{t-1}}\right) \quad (4)$$

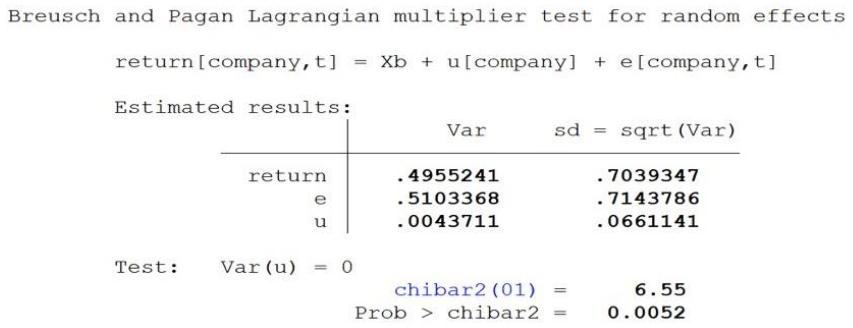
where P_t and $P_{t\text{-}1}$ represent the closing price of year *t* and *t-1*, respectively.

We are unable to obtain the first-year stock returns of the companies because the closing price for year 0 is not known. Moreover, some companies only had one-year data, while some others presented with abnormal data. Since these data cannot be used for regression, they were eliminated.

5.2. Empirical result

We used the panel data to establish the linear regression equation in Stata. We decided to select the best estimator. We first examined the Stock Returns-Z-scores relationship with robust standard errors and ran the random effects generalized least square (GLS) regression. After that, we tested the random effects

model against the pooled ordinary least squares (OLS) model using the Breusch-Pagan (B-P) Lagrange multiplier (LM) test. The results are shown in **Figure 1**.

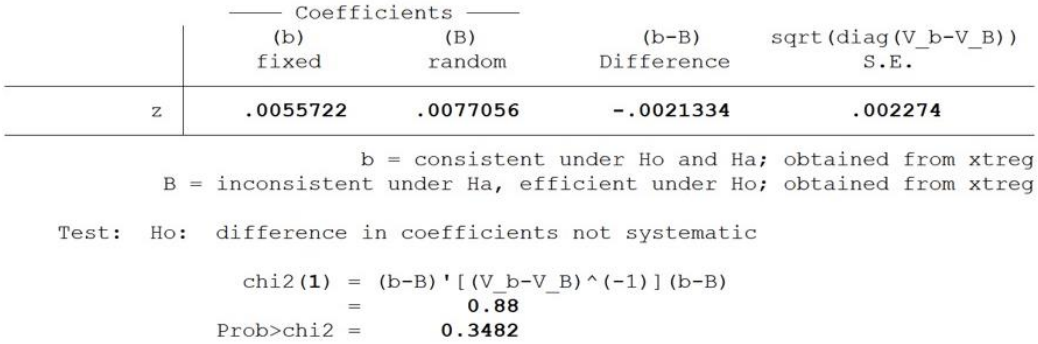


```
Breusch and Pagan Lagrangian multiplier test for random effects

        return[company,t] = Xb + u[company] + e[company,t]

        Estimated results:
                         |       Var      sd = sqrt(Var)
                ---------+------------------------------
                  return |     .4955241        .7039347
                       e |     .5103368        .7143786
                       u |     .0043711        .0661141

        Test:   Var(u) = 0
                                chibar2(01) =      6.55
                              Prob > chibar2 =    0.0052
```

Figure 1. Breusch-Pagan Lagrange multiplier test results

According to **Figure 1**, the p-value is 0.0052, so we reject the null hypothesis and choose the random effects model. We then ran the fixed-effects (within) regression and performed the Hausman test.

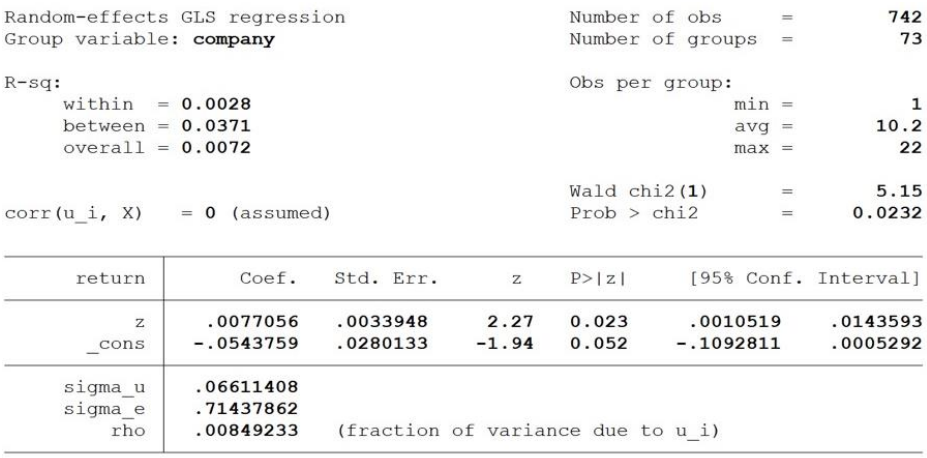
The results shown in **Figure 2** indicate that the null hypothesis cannot be rejected and that the random effects model is the best estimator.



```
                 ---- Coefficients ----
                 |      (b)          (B)          (b-B)     sqrt(diag(V_b-V_B))
                 |    fixed       random       Difference          S.E.
-----------------+------------------------------------------------------------
               z |   .0055722     .0077056      -.0021334        .002274
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(1) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =          0.88
                Prob>chi2 =        0.3482
```

Figure 2. Hausman test results

According to **Figure 3**, the regression equation is R = 0.0077Z – 0.0544. The slope is greater than 0, and the p-value is 0.023, suggesting that Stock Returns has a positive relationship with Z-scores, and it is significant at 95% confidence level.



```
Random-effects GLS regression                   Number of obs      =       742
Group variable: company                         Number of groups   =        73

R-sq:                                           Obs per group:
     within  = 0.0028                                        min =         1
     between = 0.0371                                        avg =      10.2
     overall = 0.0072                                        max =        22

                                                Wald chi2(1)       =      5.15
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0232

------------------------------------------------------------------------------
      return |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           z |   .0077056   .0033948     2.27   0.023     .0010519    .0143593
       _cons |  -.0543759   .0280133    -1.94   0.052    -.1092811    .0005292
-------------+----------------------------------------------------------------
     sigma_u |  .06611408
     sigma_e |  .71437862
         rho |  .00849233   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Figure 3. Random effects model regression

In conclusion, the research and analysis of US airline companies' data showed that there is a relationship between Z-scores and stock returns, in which the two entities are positively correlated. Firms with greater Z-scores tend to have higher stock returns, while those with weaker balance sheets underperformed the stock market. Measures should be taken to strengthen the balance sheets of companies in order to attract investors.

6. Reflection of different stock returns on Z-scores

6.1. Data and method

In order to determine the difference in Z-scores between firms with poor stock market performance and those with better performance, the procedure we followed can be briefly described in three steps: first, defining stock market performance and sorting out the data collected; second, testing the difference in Z-scores between the two general groups; third, concluding the results.

We first ranked the companies' stock performance based on their average historical price return. Since it is not possible to calculate the average stock return for a single year's worth of data and the average stock return for two years is much larger than that of firms with many years' worth of historical price returns, we culled the firms that have only one- or two-year stock returns. A ranking list consisting of the top ten firms with better stock performance and the top ten firms with poor market performance was created (as shown in **Table 1**).

Table 1. List of top 10 companies with better and poor stock performance

Group0	Average Return	Group1	Average Return
CCAIR INC	0.243382	TROPIC AIR CARGO INC	-0.330052
HUDSON GENERAL CORP	0.157466	TRANS WORLD AIRLINES	-0.331950
AIR METHODS CORP	0.155662	PINNACLE AIRLINES CORP	-0.353703
CONTINENTAL AIRLS INC -CL B	0.129239	GREAT LAKES AVIATION LTD	-0.353848
GRUPO AEROPORTUARIO SURESTE	0.128991	TOWER AIR INC	-0.381156
ALLEGIANT TRAVEL CO	0.128468	HAL INC	-0.418944
COPA HOLDINGS SA	0.127507	VANGUARD AIRLINES INC	-0.452353
COMAIR HOLDINGS INC	0.102844	TIMCO AVIATION SERVICES INC	-0.526034
ASA HOLDINGS INC	0.070337	MIDWAY AIRLINES CORP	-0.560758
ALASKA AIR GROUP INC	0.069357	VIRGIN EXPRESS HOLDINGS PLC	-0.604340

6.2. Empirical results

Second, we allocated the data of 20 companies into two groups, with the top ten average historical price return companies in Group 0, and the remaining in Group 1. We used t-test in Stata to examine whether the Z-scores differ based on the companies' stock performance. We formulated a null hypothesis (H0) and an alternative hypothesis (H1), as shown below.

$$H0: \mu z0 = \mu z1$$
$$H1: \mu z0 \neq \mu z1$$

Figure 4 shows the results of the experiment. As can be seen, the calculated value is greater than the critical value at 95% significance level with 180 degrees of freedom, and p-value = 0.000, which is smaller than 0.05, so we reject the null hypothesis and conclude that the means of both groups' Z-scores are different at the 5% level. The mean of Group 0's Z-scores is 3.83, which is higher than that of Group 1.

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	125	3.829601	.5189119	5.801611	2.802529	4.856673
1	57	-2.022742	.8620919	6.508651	-3.74972	-.2957645
combined	182	1.996724	.4893005	6.601025	1.031257	2.962191
diff		5.852343	.9638165		3.950511	7.754176

diff = mean(0) - mean(1) t = 6.0721
Ho: diff = 0 degrees of freedom = 180

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0
Pr(T < t) = 1.0000 Pr(|T| > |t|) = 0.0000 Pr(T > t) = 0.0000

Figure 4. t-test results

In conclusion, the analysis of US airline companies' data showed that there is a difference in Z-scores between firms with distinct stock performance. Firms that performed better are more likely to have higher Z-scores; on the contrary, those firms that have poor performance tend to have lower Z-scores.

7. Conclusion

This study is based on a number of relevant literatures. Most of these literatures have indicated that Altman's Z-score model is a very effective tool for predicting the likelihood of a company's bankruptcy. The model can also be used to assess, to some extent, the market performance of companies and the stock price trend; however, some studies have demonstrated that Z-scores do not necessarily reflect the stock return of companies.

After screening, processing, and sorting 840 pieces of data generated from 81 airline companies, we attempt to prove the ability of Z-scores in evaluating the market performance of US airline companies. Under the premise of using the annual stock return rate as an indicator of stock returns, this paper finds that Z-scores have a positive correlation with the annual return rate of airline companies in the US market, *i.e.*, a high Z-score implies better market performance in the US market. In addition, this paper divides the sample companies into two groups, one with relatively good market performance and the other with relatively poor market performance, in order to determine whether the Z-scores of the two groups would show significant difference. The results show that, except for Trans World Airlines, the Z-score values will be different provided that the companies' market performances are different: in the US market, the Z-score value of an airline company with high annual return on stock will be higher than that of a company with lower annual return on stock.

The two experiments in this paper, to some extent, prove the effectiveness and feasibility of Altman's Z-score model in evaluating the stock performance of US airline companies. In other words, the strength of a company's balance sheet has certain reference value as an indicator to the outcome of stock return. Therefore, in order to attract more investors, measures should be taken by US airline companies to strengthen their balance sheet, which will be reflected in their stock price ultimately.

Disclosure statement

The authors declare no conflict of interest.

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