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Application of the Altman Z'' Score Model in Forecasting the Financial Position of BIST Companies

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ABSTRACT

For measuring financial performances of companies and identifying financial failure, there are a lot of models in the literature. Among these models, Z Score model is of the most used in terms of its being an accounting-based model and simple applicability. The purpose of this paper is found out whether the Z" Score model, which was revised by Altman, could be useful in making financial decisions about long-term firm value. For this purpose, panel cointegration analyzes were carried out among the variables, with the firm values of the publicly traded companies listed on the Turkish BIST (Istanbul Stock Exchange) as the independent variable and the Z" Score values as the dependent variable. Although the research is specific to Turkey, the results of the research are considered to be applicable globally, as Altman states that the Z" Score model can also be used by developing country companies. It has been proven that Altman Z" Score Model, applied in public company, has a high prediction power directed to financial success of the firms. According to the results of the analysis, 1 unit increase in the Z" Score values of the companies cause an increase of 0.353 units in the logarithmic return calculated over the firm value. Z" Score Model can be a precious indicator for heads of companies, accounting and financial managers, auditors, creditors, investors to make accurate decisions directed to assessing financial structures of companies in advance.

Keywords: Accounting based prediction model; financial distress; Altman Z-Score; BIST

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INTRODUCTION

The firms, which cannot perform the requirements of market conditions, due to the fact that economic and financial troubles they face of, experience difficulties in sustaining their lives. The studies show that these problems that we can refer to business failure arise from bad management of firms [1].

Although there are many reasons for business failure, these reasons were classified in the literature as economic and financial failure in two main areas [2]. Economic failure emerges in case those firms cannot obtain income as much as it can meet costs forming in activity process [3, 4]. Economic failure may not create any problem for the business, which has a strong structure and paying power for their debts. Also, after the income generating activities, business can reach its profit targets in time.

Financial failure emerges in case of not being able to pay for debts in their due dates [5]. Financial failure is the insufficiency of the acts made directed to identifying financial performances of the firms [6–8]. Financial performance can be expressed as activity abilities of business managers for asset management and control [9]. Being able to take action by the managers can be possible by predicting financial failure in advance.

The use of an accounting-based structure in measuring fiscal performance and analysis of fiscal tables obtained from accounting data contribute performance measurement. The ratios that will be obtained from financial tables will provide information about the existing situation and future of the business. The analyses to be made will provide critical information for many parts such as company managers, investors, creditors and government while identifying possible problems to emerge in financial structures of companies provides for the in-business users to take necessary precautions from financial point of view, in viewpoint of out-business parts, it will be a guide in arranging the relationships with company [10].

Not being able to identify the problems occurring in financial structures of businesses and not being able to take the necessary actions in time are generally ended with bankrupt, and this case causes the formation of serious costs negatively affecting both companies and all stakeholders related to the company [1, 11, 12]. In these stages, taking businesses to bankrupt, using certain methods for predicting failure will enable to take action with lower cost without facing to heavy cost of bankrupt [13, 14].

It is known that many prediction methods were developed for identifying the problems in financial structures of the businesses in advance [15–21].

One of the most encountered methods in the literature for testing financial structure and identifying bankrupt risk is Altman Z Score model. Besides that, Altman Z Score model is used in the areas such as merging and acquisition, credit risk analysis and return methods as danger measurement, this model has been begun to be used for the purpose of measuring performance [22]. The Altman Z Score model is a useful model not only for predicting bankruptcy, but also for measuring financial performance [23].

The most interesting study for identifying financial performances and successes via proportioning the variables taking place in financial tables was carried out by Beaver in 1966. In this study, used a univariate analysis as a traditional method [24]. After this study, Altman, using Multiple Discriminant Analysis (MDA), developed a new model in 1968. This model was broadly accepted besides that it had a high accuracy level, due to the fact that it could be used in assessing financial performances of firm managers, analyses of management accounting and presenting predictions in identification of fiscal structures as well as decision making processes of the various stakeholders such as investors, creditors, auditors, consultants [25, 26].

The study was divided into three sections, including introduction and conclusion sections. The first section theoretically describes Altman Z Score model and, the second section includes empirical examination of the literature about this method. The third section includes database and study method and, the last section presents a discussion about Turkey-specific results and their effects.

ALTMAN Z SCORE MODEL IN LITERATURE

Z Score Model, which is the first multiple variable model for measuring performances of financial structures and identifying financial failure, was developed by Altman Edward in 1968 [27]. Easily application of the method through accounting data and its success on performance results directed to identifying financial failure enabled the model to be used in a wide area and to be acceptable [28, 29].

The first Altman Score Model is based on the assumption that there is a linear relationship between financial failure and the ratios obtained from financial tables [30]. In the study, using 22 financial ratios, calculated through the values obtained from financial tables, were used. In the direction of the results obtained, 5 financial ratios, which is accepted that they identify financial failure, were reached [31].

Financial rates, accepted that they identify failure in Altman's original model, are [6]:

$X1$: 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 debt;

$X5$: Sales/Total assets.

Discriminant function, first developed by Altman and called Z Score, is as follows [15]:

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

The possible results of Z Score are determined according to the flowing limit values [15]:

- $Z \leqslant 1.80$: High Risk (Distress Zone);
- $1.81 \leqslant Z \leqslant 2.99$: Uncertain (Grey Zone);
- $Z > 2.99$: Low risk (Safe Zone).

It was identified by the researcher that the first model formed could predict accurately the financial successfulness of unsuccessfulness of the firms in the rate of 95% with the one year ago data and accurately in the rate of 72% with two years ago data [15].

The first Altman Z Score model was formed for public businesses. However, financial structures of non-public businesses differ from financial structures of public businesses. Especially, due to weakness in cash flows of non-public businesses, they face to more financial problems [32]. Altman noticing this problem updated model in the following years.

Discriminant function revised by Altman is as follows [33]:

$$Z': 0.717 * X1 + 0.847 * X2 + 3.107 * X3 + 0.420 * X4 + 0.998 * X5$$

$X1$ = working capital / total assets;

$X2$ = retained earnings/ total assets;

$X3$ = earnings before interest and taxes / total assets;

$X4$ = book value of equity/ book value of total liabilities;

$X5$ = sales/ total assets.

After this modification, Z Score classification areas were also again determined,

- $Z' < 1.23$: High Risk (Distress Zone);
- $1.23 \leqslant Z' \leqslant 2.90$: Uncertain (Grey Zone);
- $Z' > 2.90$: Low risk (Safe Zone).

Altman, for Z Score model to be able to be used except manufacturing businesses, revised the model once more. Altman, eliminating the variable of X5 sales/total assets, formed four variable Z" score model.

Four variable Z" Score model, is as follows [17, 33]:

$Z'' = 6.56\,(X1) + 3.26\,(X2) + 6.72\,(X3) + 1.05\,(X4)$.

After this modification, Z Score classification areas were also again determined. According to this:

Z" Score < 1,10: High Risk (Distress Zone)

1.10 ⩽ Z" Score ⩽ 2.60: Uncertain (Grey Zone)

Z" Score > 2.60: Low risk (Safe Zone)

Altman theory, for distinguishing whether or not quantitative models such as Multiple Discriminant Analysis (MDA) will show sufficient performance from financial point of view, is important in terms of that it shows that financial ratios can be used. Altman Z Score model, which has a scientific support and uses accounting data, is also continuously used at the present time by market markers both in academic studies and as an indicator of basic analysis.

Also, in this study carried out, it was focused on Altman Z" Score model, revised by Altman, that is highly acceptable in the literature [2, 15–17, 20, 24, 25, 33, 35–43].

METHODOLOGY

The Aim of the Study and Database

The last revised Altman Z" score is a model that can be applied in developing countries [44]. In the study, Altman Z" score success has been tested by using the financial statement data of publicly traded companies in Turkey, which is the developing country model.

When Altman Z Score coefficients are examined, Z" < 1.1 shows high bankrupt risk; 1.1 <= Z" < 2.60, grey zone and Z" >= 2.60, good condition of the firm [45, 46]. If there is a relationship between Z'' Score values and financial performance of firms, this relationship will have to effect market value of firms. In order to test hypothesis formed, Z" Score results of the firms recorded in Istanbul Stock Exchange (BIST) and market values of these firms were used in the study. In the hypothesis established, all companies registered in BIST were evaluated to obtain the most accurate result, and financial sector representatives from these companies were excluded because they had different balance sheet structures. By examining the data continuity of the companies registered in BIST, the longest possible period for the research was determined. According to this examination, it was decided that the most suitable study period for the study was 38 periods between 2nd quarter (six months) of 2012 and 3rd quarter (9 months) of 2021. As a result of all of these examinations, 111 firms and quarterly financial tables of 38 periods of these firms and market values of the firms were included as dataset in the study carried out. The firms being subject of the study were shown in *Table 1*.

Z" Score values of the companies were calculated as shown in the formula (1).

$$Z''\ \text{Score} = 6.56X1 + 3.26X2 + 6.72X3 + 1.05X4 \quad (1)$$

Firm value data, which is the independent variable of the research, is calculated from the market values of the companies shown in *Table 1*, reported in BIST. In the calculation of the firm value variable, the logarithmic return was calculated over the 3-month market values of the companies included in the analysis.

$$\text{Ln (return)} = \ln\,(P_{n+1}/P_n) \quad (2)$$

The purpose of using logarithmic return value instead of using firm value, is to avoid the stationary problem that may arise in the time series. As a result, the increase or decrease in the logarithmic return will not harm the basic question of the research, since it directly depends on the increase or decrease in the value of the firm.

In the dataset formed, due to the fact that it contains both time and cross-sectional vales, dataset turned into panel data set in the scale of 38×111.Although that analyses are made on the panel datasets is partly similar to time series, it also contains many differences. The most important one of these differences and element that is necessary to be studied is horizontal cross-sectional dependence. Other than cross-sectional dependence, additionally, studying homogeneity on

Table 1

BIST Firms Being the Study Subject

ADEL	ARMDA	BTCIM	DOKTA	GUBRF	KRSTL	PETKM	TKFEN
AEFES	ARSAN	BUCIM	ECILC	HATEK	KRTEK	PETUN	TOASO
AFYON	ASELS	CCOLA	EGGUB	HEKTS	KUTPO	PINSU	TTKOM
AKCNS	ATEKS	CELHA	EGPRO	INDES	LINK	PKART	TTRAK
AKENR	AVTUR	CEMTS	EGSER	IPEKE	LKMNH	PNSUT	TUPRS
AKSA	AYGAZ	CIMSA	ENKAI	KAREL	MNDRS	PRKAB	ULKER
AKSEN	BAGFS	CLEBI	ERBOS	KARTN	MRSHL	SARKY	USAK
ALARK	BAKAB	CMENT	EREGL	KENT	NETAS	SELEC	UTPYA
ALCAR	BIMAS	DERIM	ESCOM	KLMSN	NUHCM	SISE	VESBE
ALCTL	BIZIM	DESA	ETYAT	KNFRT	OLMK	TATGD	VESTL
ALKIM	BLCYT	DESPC	FROTO	KONYA	ORGE	TBORG	VKING
ALMAD	BRISA	DGATE	GENTS	KOZAA	OTKAR	TCELL	YAPRK
ANELE	BRSAN	DOAS	GOLTS	KOZAL	OYAKC	TGSAS	YATAS
ARCLK	BSOKE	DOBUR	GOODY	KRONT	PARSN	THYAO	

Source: Compiled by the author.

dataset is highly important for panel data analysis. Depending on analyzing these two elements, the analyses to be made will differ.

HORIZONTAL CROSS-SECTIONAL DEPENDENCE

Cross-sectional data exhibit a behavior in the direction of commonly moving, the correlation appears between cross-sectional data, and this state refers to horizontal cross-sectional dependence. Between cross-sectional data, the results of the analyses to be made without considering horizontal cross-sectional study are relatively different and can be misleading for the researcher [47–49].

For studying horizontal cross-sectional dependence, a lot of models were developed. These models are LM test [47], CD test [48] and NLM test [50]. The method to be used to select the most suitable one among these tests is basically is: if time series (T) is bigger than cross-sectional series (N), LM test should be chosen; if $N > T$, CD test; and if N and T reach big values, NLM test; CD calculates correlation between the residuals obtained as a result of ADF (Augmented Dickey-Fuller) in horizontal cross-sectional dependence test [51].

For being able to be calculated Pesaran CD test,

$$CD = \sqrt{\frac{2T}{N(N-1)}}\left(\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{\rho}_{ij}\right) \quad (3)$$

$$\hat{\rho}_{ij} = \hat{\rho}_{ji} = \frac{\sum_{t=1}^{T} e_{it}e_{jt}}{\left(\sum_{t=1}^{T} e_{it}^2\right)^{1/2}\left(\sum_{t=1}^{T} e_{ij}^2\right)^{1/2}} \quad (4)$$

e_{it} and e_{ij} are the residuals obtained as a result of regression, represent correlation and $\hat{\rho}_{ij}$ i and j. The hypotheses formed for the test made are [48]:

H_0: There is no correlation between cross-sections;

H_1: There is a correlation between cross-sections.

In this study carried out, in the size of $N = 111$ and $T = 38$, there are two variables as Z" and Ln (return). The results of Pesaran CD test and the other horizontal cross-sectional dependence test are presented in *Table 2*.

When the test results of three horizontal cross-sectional dependence, made on the variables of Z" Score and Ln (return) that are the subject of the study, are examined, depending on the result of $p < 0.05$ for each

Table 2

The Results of Horizontal Cross-Sectional Dependence Test

Test	Ln (return)			Z" Score		
	Statistic	d.f.	Prob.	Statistic	d.f.	Prob.
LM	229992.0	6216	0.00	242424.0	6216	0.00
CD	4.795,748		0.00	4.923.657		0.00
NLM	2.005,975		0.00	2.117.474		0.00

Source: Compiled by the author.

test and variable, H_1 is accepted, while H_0 is rejected. According to these acceptations, it is reached the conclusion that the variables have correlation on their own cross-sections and cross-sectional dependence cannot be rejected.

HOMOGENEITY TEST

If a variation in one of cross-sectional variables also shows similar effects on the other cross-sectional variables, we say that panel data structure is homogenous, otherwise, that it is heterogeneous [52]. In addition, whether or not panel data is homogenous play's important role in the preference of the analyses that will be made later.

In this study made, using Hsiao C. [53] homogeneity test, homogeneity of panel-data set was tested. In Hsiao Homogeneity Test, three hypotheses are formed as H_1, H_2 and H_3 are formed. While H_1 and H_2 hypotheses accept that model coefficients are homogeneous, H_3 hypothesis accepts that these coefficients are partly homogeneous [54]. The results of Hsiao Homogeneity Test are shown in *Table 3*.

In the results of Hsiao Homogeneity Test, since $p < 0.05$, homogeneity of panel-data set cannot be rejected. According to the results of horizontal cross-sectional dependence and homogeneity tests, it will be decided which test can be used for unit root tests, the next step.

In case that there is no horizontal sectional dependence, while 1st generation unit root tests can be applied, in case that there is horizontal cross-sectional dependence, 1st generation unit root tests give misleading results. In case that there is horizontal cross-sectional dependence, MADF [55], SURADF [56] and CADF (CIPS) [57] tests are recommended, which are among 2nd generation unit root tests. However, from among these tests, in the cases of $N > T$ and $T < N$, CIPS test gives the most reliable results [58]. Also, in this study carried out, CPS unit root test was chosen, depending on specified reasons.

CADF test, developed by Pesaran, was developed in terms of cross-section and while both $T > N$ and e $N > T$, it gives reliable results in panel data analyses under horizontal sectional dependence. The other feature of this test is that it is a heterogeneous test. Pesaran CADF is based on the model given below [58]. In case that there is no autocorrelation, panel data model is the same as that shown in formula (5).

$$Y_{it} = (1-\varnothing_i)\mu_i + \varnothing_i Y_{i,t-1} + u_{it}, \quad (5)$$

when f_t is accepted as unobserved factor and if u_{it} has a structure of single factor, u_{it} is expressed as shown in formula (6) [51]:

$$u_{it} = \gamma_i f_t + e_{it}, \quad (6)$$

when u_{it} is placed in the model, the new model will turn into the shape shown in the formula (7).

$$\Delta Y_{it} = \alpha_i + \rho_i Y_{i,t-1} + \gamma_i f_t + e_{it} \quad (7)$$

$$\Delta Y_{it} = Y_{it} - Y_{it-1},\ \alpha_i = (1-\varnothing_i)\mu_i \text{ and } \rho_i = (1-\varnothing_i) \quad (8)$$

Pesaran, taking arithmetic means of each series, H_0 and H_1 hypotheses through CIPS values.

$$CIPS(N,T) = \frac{\sum_{i=1}^{N} t_i(N,T)}{N} \quad (9)$$

Table 3

The Results of Hsiao Homogeneity Test

H1 = Null Hypothesis: panel is homogeneous Alternative Hyp.: *H2*		
H2 = Null Hypothesis: panel is heterogeneous Alternative Hyp.: *H3*		
H3 = Null Hypothesis: panel is homogeneous Alternative Hyp.: panel is partially homogeneous		
Hypothesis	***F*-Stat**	***P*-Value**
H1	0.00	1.00
H2	0.00	1.00
H3	0.00	1.00

Source: Compiled by the author.

Table 4

Pesaran CIPS Unit Root Test Results

Z" CIPS* = −2.219 *N, T* = (111.38)				**Ln (return) CIPS* = −4.730 *N, T* = (111,38)**		
	10%	5%	1%	10%	5%	1%
Critical values at	−2.01	−2.06	−2.14	−2.01	−2.06	−2.14

Source: Compiled by the author.

H_0: There is unit root;

H_1: There is no unit root.

Depending on the theoretical explanations, the results of unit root realized are shown in *Table 4*.

As shown in *Table 4*, since CIPS value for both variables is bigger than critical value of 1%, H_0 is rejected, and it is accepted that there is no unit root in the variables.

Since it was identified that both variables were stationary at the level, the presence of the relationship between both variables will be studied by Panel LS test.

PANEL LS TEST

The presence of correlations between horizontal cross-sections of the variables was identified in the previous sections. In addition, it was also identified that the coefficients of the variables exhibited a homogenous distribution. Depending on these identifications, on homogenous panel data that has horizontal cross-sectional dependence, PDOLS (Panel Dynamic Least Square) Model among second generation analyses can be used [51]. PDOLS analyses come to our face as long-term predictions and in order to eliminate the effect of intersectional correlation, add the premise and lagged value of the variables to model and internal feedback to independent variable disappears [59]. PDOLS analysis model are shown below [60];

$$Y_{it} = \alpha_i + x_{it}\beta + \sum_{j=-q}^{q} c_{ij}\Delta x_{it} + v_{it} \qquad (10)$$

c_{ij} , added to the model formed is the coefficient of premise and lagged values of explanatory variable, taken first difference.

For being able to be realized Panel LS test, it is necessary to study that model has to which of fixed effects, random effects or pooled effect. In order to be able to identify the existing effect in the model, it is necessary to make Hausman, Chow (F) and Breush-Pagan LM test. Without entering to the theoretical explanation of these tests, hypotheses of any test were shown in *Table 5*.

The hypotheses formed were tested on both horizontal cross-l sectional and time plane and test results were shown in *Table 6*.

When the results of the tests are examined, Hausman test accepts that the variables have the random effect, while F Test enables to be made preference between pooled effect and fixed effect for the variables. According to the results of F Test made, the variables have pooled effect. Breush-Pagan LM test enables to be made preference between random effect and pooled effect

Table 5

Effect Hypothesis

Hausman Test	Chow(F) Test	Breush-Pagan LM Test
H_0: random effect	H_0: pooled effect	H_0: pooled effect
H_1: fixed effect	H_1: fixed effect	H_1: random effect

Source: Compiled by the author.

Table 6

Effect Test Results

	P değeri	H_0	H_1	Etki
Hausman Test	0.9972	Ok	Reject	random effect
F Test	0.9998	Ok	Reject	pooled effect
B-P LM Test	1.0000	Ok	Reject	pooled effect

Source: Compiled by the author.

Table 7

PDOLS Test Results

Dependet Variable: Ln(return)				
Variable	**Coefficient**	**Std. Er.**	***t*-Stat.**	**Prob.**
Z”	0.353028*	0.004486	78.68831	0.00
R-squared	0.837398	Adjusted R-squared		0.759935
*$p < .01$				

Source: Compiled by the author.

and, according to the result of the test, identified that the variables have random effect.

As a result of all tests made, the following model is suggested, in which Ln (return) is dependent variable and Altman Z” Score value is independent variable.

$$Ln(return)_{it} = \alpha_i + Z''_{it}\,\beta + \sum_{j=-q}^{q} c_{ij}\Delta Z''_{it\,it} + v_{it} \quad (11)$$

According to PDOLS analysis results (*Table 7*) since $P < 0.05$, Z’’ affects the variable of Ln(return), hence, hypothesis is not rejected. In addition, in the analysis, when R^2 value is examined, significance level of the model formed was identified as 0.837 and this significance level can be accepted as relatively high. Lastly, it is understood that Altman’s Z” model affects firm value in the rate of 0.35. Depending on all results obtained, although Altman Z” model is formed to measure financial failure of the firms, it is demonstrated that it can be also used to predict the increase or decrease in firm value in the long term.

CONCLUSION AND SUGGESTIONS

In Turkey, identifying the financial conditions of the companies recorded to BIST and, thanks to this, according to the results obtained in this study carried out to measure the success of the model in terms of decision makers, it was identified that there was a relationship between Altman Z” score value and firm value at high significance level.

According to the PDOLS model established between the dependent variable Ln (Return) and the independent variable Z" value; A 1-unit increase in the Z" score value causes an increase of 0.353 units in the logarithmic return calculated over the firm value.

When the literature is examined, all of the studies on the Z" Score model have investigated the financial failures of the companies. In this study, it has been revealed that the Z Score model can be used not only to measure financial failure, but also to make firm value estimations in the future. From this point of view, this study has made an important contribution to the finance and accounting literature. Depending on this identification:

- Altman Z" score model is valid the other firms, recorded in Istanbul Stock Market, other than financial firms
- Increases in the value of Altman Z" score contribute to the increases of firm values.
- Following Altman Z" Score values will make contribution to long term investment.
- Since Altman Z Score values are calculated at the end of accounting records, especially in the period, in which financial tables are explained, that they also explain Z Score values will provide more prediction infrastructure for investors.
- Altman proposes the Z" Score model as a model that can be used by developing countries globally. Depending on this proposition, it is thought that the results of this study conducted in Turkey may be suitable for other developing country companies as well.

Depending on these results, in the next study, it will be suitable to prepare an index for investors through Altman Z Score value. In addition, the next studies can be focused on testing prediction accuracy of the models in sectorial basis. This study is focused on the companies, which are dealt in BIST. When considered that many small and medium –sized enterprises (SMSEs) in Turkey default due to cash flow problems, it will also be interesting accuracy of models to test on non-quotation SMSEs and service enterprises in stock market in Turkey.

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