DOI: 10.55643/fcaptp.1.48.2023.3971

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Received: 26/01/2023
Accepted: 22/02/2023
Published: 28/02/2023

USE OF ACCOUNTING-BASED MODELS FOR MEASUREMENT OF FINANCIAL PERFORMANCE: COMPARISON OF ALTMAN Z'' AND MFA SCORE

ABSTRACT

The aim of this study is to try to identify the presence of a relationship between index results of the Altman Z'' Score and MFA Score Models and the market values of the firms and to determine which model is more effective among these models. In a comparison of the two models, which is the study subject, the service sector was specially chosen. The main reason for preferring the service sector is that Altman Z'' Score Model was formed by firstly modifying the original Altman Z'' Score Model for the firms in the USA (United States of America) Service Sector. However, later, it was identified and recommended that this model was also valid for the firms of developing countries, MFA Score Model is a model developed specifically for Turkey. It was desired to identify that it can be measured not only the financial failures of the firms of interest but also their possible achievements in the future and to compare both models. Thus, for middle and long-term investors, investment support information based on more scientific fundamentals will be introduced. In addition, a dataset which will support the decision processes of in-firm stakeholders other than investors will be reached.

In order to be able to reach the aims of interest, BIST in the service sector was used in the study. In the study, panel time series co-integration data were used and, as a result, it was understood that Altman Z'' –Score Model made an effect of 36.3% to the firm value for a lagging of one period, while MFA Model made an effect of 51.9% to the firm value for a lagging of one period. According to this, it was identified that MFA model data were more effective in the prediction of firm value.

Keywords: accounting-based model, financial accounts, Altman Z model, MFA model, service business

JEL Classification: G10, M40, M41

INTRODUCTION

The financial failure of the firms is seen as an important risk from the aspect of in-firm and out-firm parts and leads to worry. Financial failure is defined as the case that a business cannot fulfil its financial obligations (Shariq, 2016). In terms of partners, managers and employees in the firm and of customers, suppliers, government and, generally, society, this risk constitutes an important problem for the formation and development of the market (Munoz et al. 2019). When evaluated from this aspect, it is necessary to make analyses for predicting financial failure. Financial analyses will give direction to the making decision processes of the parts and to their relationships with the firm and enable more sound relationships to form. The causes leading to financial failure can be divided into two groups, financial and social. Economic causes are the ones generally emerging as external problems in the process of decreasing interest in goods and services as well as fulfilling obligations against third persons (Panigrahi, 2019). However, financial causes emerge after not being able to fulfil obligations, depending on financial inabilities in the financial structure of the firm. In general, it is expressed as the problems emerging in the firm (Montalvan et al., 2011).

In the direction of the close relationship existing between economic and financial indicators, firms can simultaneously face both internal and external problems. For predicting the causes inducing financial failure and minimizing risk, firms can monitor their financial

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situations through the reports they introduce with their accounting information. Therefore, they utilize financial analysis techniques (Freire et al., 2016). Using accounting data is highly useful in predicting financial failure. Analyzing the financial tables of the firms makes it possible to predict the current period of the firms and the problems they can face in the future. Using financial ratios in using financial tables of the firms, and identifying their financial performances come into our face as one of the principal methods used.

Measurement of financial achievements of the firms dates to Fitzpatrick (1931). In these studies, in this period, in which the financial achievements of the firms are measured, univariate measurements are used. The first study making multivariate measurements by using Multiple Discriminant Analysis (MDA) is Altman's (1968) Z-Score Model (Çolak, 2019). Also, Altman Z-Score Model is the leading prediction instrument among the most popular measurement ones in measuring financial achievement and failure and is commonly used in the literature due to application easiness, depending on accounting data (Sucurro et al. 2019). Z-Score Model use accounting data, reported by means of tables, as original information. Altman Z-Score is a highly useful indicator for analyzing the existing state of the company structure, its potential structure and tendencies in the future (Roque and Carrero, 2022). Altman's (1968) Z-Score, the first version of the model, was applied to public manufacturing firms taking place in the US market. The results obtained provided high achievement associated with predicting financial failure. Altman, in the next years, developed this model to provide applicability of the Z-Score Model in non-public and service businesses.

Achievement of the model increased the interest regarding its applicability in developing and less developed countries other than the developed countries in terms of economic and financial differences and the various authors revised the model on the basis of countries (Roque and Carrero). In this sense, in Turkey, there are some studies directed to the applicability of the model. Among these studies, Çolak (2019), in the study he carried out, applying Altman's (68)Z-Score model to the companies taking place in BIST in Turkey, revised the model. It was identified that the model, revised and formed together with new coefficients, gave better results on the firms in Turkey compared to the original model in predicting financial failure risk. Çolak, in the same study, in order to predict financial failure risk, developing a new model, called MFA Score, consisting of 7 financial ratios, introduced Turkey-specific applicable model. MFA Score predicts financial failure at the rate of 92.6% on the basis of one-year ago basis. From this aspect, it is seen that the MFA model is more successful than the results of the original model and the model, obtained with the revised coefficients.

LITERATURE REVIEW

As an accounting-based approach directed to predicting the financial failure of the firms, the studies carried out by using ration analysis techniques have taken place in the literature since the 1930s (Fitzpatrick, 1931; Smith and Winakor, 1935; Wall, 1936). In the process dating to the mid-1960s, the studies carried out were focused on univariate discriminant analysis associated with ratio analysis. Among these studies, the most acceptable ones are the studies by Beaver (1966). (Bellovary et al, 2007). The first model focused on multidirectional discriminant analysis directed to predicting financial failure was published by Altman in 1968. Altman, using 5 financial ratios he identified as the most effective in predicting financial failure from among 22 potential ratios, which he drew from financial tables of the firms, on the purpose of combining in a single indicator (Z-Score), utilized multiple discriminant analysis (Çolak 2019).

The first multivariate model developed by Altman (1968) is as follows:

$$Z= 1.2\ X1+ 1.4\ X2+ 3.3\ X3+ 0.6\ X4+ 0{,}999\ X5$$

where; Z = Z – score; X_1 = working capital/total assets; X_2 = undistributed profits /total assets; X_3 =earnings before interest and tax /total assets; X_4 = total market value of equities/ book value of debts; X_5 =sales/total assets.

In addition, Altman suggests that the firms can be divided into three zones according to Z-Score value as safe zone (Z > 2.99), grey zone (Z < 2.99) and dangerous zone (Z < 1.81) (Altman, 1968). The original Z-Score Model is criticized from the aspect of its development according to the data of only the firms dealt in the stock market and its applicability in public firms. Therefore, he again revised Altman Model.

In 1983, for the original model to be applied to manufacturing companies not being dealt in the stock market, Altman developed a new model. Altman revised the variable "X4= total market value of equities/ book value of debts" used in the first model to "Book Value of Equity/Total Liabilities". Thus, a new Z-Score Model formed as follows (Altman, 1983)

$$Z' = 0.717\ X1+ 0.847\ X2+ 3.107\ X3+ 0.42\ X4+ 0.998\ X5$$

Altman suggests that the firms can be divided into three zones according to Z-Score value as safe zone (Z > 2.9), grey zone (1.23 < Z < 2.9) and dangerous zone (Z < 1.23) (Altman, 1968).

Altman, later, developed Z"-Score Model for the model to be used in public companies as well as non-manufacturing sectors. In the next studies, it was understood that this third model was the most effective model for all sectors of developing countries including service sectors. Altman, eliminating, the variable X5 sales/total asset, formed four variables Z"-Score Model (Hanson, 2003). This model developed by Altman is as follows:

Z''= 6.56 X1+ 3.26 X2+ 6.72 X3+ 1.05 X4 (Alcalde vd. 2022)

Altman suggests that the firms can be divided into three zones according to Z"-Score values as safe zone (Z > 2.6), grey zone (1.1 < Z < 2.6) and dangerous zone (Z < 1

Altman Z"-Score Model, together with the revisions made beginning from the years it was published, is one of the most used models used accounting, banking and financing literature including practitioners (Grice and Dugan, 2001, Agarwal and Taffler, 2007)

In the literature, the ability of the Altman Z-Score Model to measure financial failure risk specific to the different countries is compared by means of accounting-based models developed and its efficiency is tested. In the literature, some studies carried out for this purpose were shown as an example.

Grice and Dugan (2001) developed a new model (SBM), using Altman's Z and Z' models and the non-parametric VZA method. This model is important in terms of it introducing a practical approach for predicting institutional failure, especially in non-manufacturing firms. SBM Model gives more successful results on small and middle-sized non-manufacturing or retailing companies, which are not suitable for using Altman –Z" model.

Al-Khatib and Al-Bzour (2011), in the studies they carried out, aim to identify which of Altman and Kida's Models is more successful in predicting failure. The sample of the study is 16 non-financial firms, which take place in the service and industrial sectors and go bankrupt. [In the study], financial ratios of the firms between 1990-2006 were used. 16 firms were compared with 16 firms, which were successful for each year in the last five years before bankrupt. As a result of the average value of 5 years, the ability of the Altman Z-Score model to predict bankruptcy is 93.8%, and that of the Kida Model is 69%. The results show that Altman Z-Score Model is more successful.

Rizqa Humairoh. et al (2022) in the study they carried out, compared Altman Z-Skore, Springate and Ohlson models for predicting financial failure. In Indonesia, the 2015-2020 financial table data of non-financial companies were used. In the study, as an analysis technique, logistic regression analysis and chi-square analysis were used. According to the logistic regression test, Altman Z-Score Model have the ability to accurately predict financial failure risk at the rate of 86.3%; Springate Model, 83.8%; Ohlson Model, 86.3%. According to Chi-Square test results, the Altman model predicts failure risk accurately at the rate of 71.25%; the Springate model, 55% and Ohlson, 65%.

Edi and Tania (2018), in their studies, for measurement of financial achievement in terms of the companies in Indonesia, the results of Altman Z-Score, Springate, Zmijewski and Grover Models compare. In the study, the data containing the period 2012-2016 of the firms taking place in the Indonesia Stock Market were used. The data are financial tables of each company. The data obtained was tested by means of logistic regression. According to the results of the test associated with the coefficient of identifying financial failure, it was concluded that Springate Model is a model that has the highest accuracy value of 69.7%.

Begley et al. (1996) studied whether or not Altman and Ohlson models will give successful results in the same way, when the data of closer periods are used. For this purpose, using the data of 165 bankrupted firms in the period 1980-1989 being dealt in New York Security Exchange (NYSE), American Security Exchange (AMEX) and NASDAQ and of randomly selected 3300 non-bankrupt firms, both models were again predicted. When coefficients are again predicted, it was concluded that both models did not show a good performance according to the periods they were originally predicted. As real reasons for this, the increases in acceptable institutional level after 1980 and amendment in bankrupt law are shown.

Aminian, Mousazade and Khoshkho (2016) use the 2008-2013 period data of 35 companies among textile, ceramic and tile companies being dealt Tehran Security Exchange. In the study, using these data, they tested the achievement of Altman, Springate, Zmijewski and Grover Models to predict financial performance for Tehran firms. According to the results of the studies carried out by using the Panel and multiple linear regression method, they identified that Grover, Altman, Springate and Zmijewski models had the ability to better financial crises, respectively.

DOI: 10.55643/fcaptp.1.48.2023.3971

Wu et al (2022), using the database obtained from financial tables of all companies dealing in Shenzhen and Shanghai Stock Markets, carried out their studies through 293 company data that have trouble from the financial point of view and 16.913 company data that are successful from the financial point of view. The aim of the study is to develop a hybrid crisis model combining Z-Score Model and MLP ANN. Empirical results identified that the new hybrid model could reach the highest average classification rate (99.40%) when it was compared with Z-Score Model (86.54%) and pure network method (98.26%).

Xhindi and Shestani (2020), in their studies they carried out in Albania, used a dataset consisting of the period 2015-2016 of 204 active companies and 163 unsuccessful companies. All companies evaluated are in the manufacturing industry. With Altman Z" Score Model (1993) adapted to private companies, the run of this model was tested in association with predicting financial failure risk. In addition, in the study, a new regression model is suggested. The newly suggested logistic regression model is more successful in accurately predicting bankruptcy compared to Altman Z"Score Model. The authors state that problems such as Albanian market conditions and unreal financial reporting and financial trafficking can be effective in the failure of the Altman Z" Score Model.

Asgari, (2008), in the study he carried out, in order to measure the achievement of Springate, Zavgin and Falmerto Models, used the data of financial table data of the companies dealing in the Tehran Security Exchange. Asgari, (2008) reached the conclusion that the Springate model has a 90% of confidence level in predicting firm bankrupts compared to the Falmer ve Zavgin models

Güçlü (2021), in the study he carried out in Turkey, used the secondary dataset compiled from the period 2016-2020 annual financial reports of 14 businesses taking place BIST Participation 50 index. In the prediction of financial failure and bankrupt risk, Altman-Z', Altman-Z" and Springate Models were compared. It is seen that the results of the Altman-Z" and Springate Models are similar and that stock certificates in BIST Participation 50 Index have generally more healthy structure.

Almamy et al., (2016), in order to test which ratios are statistically significant in predicting the financial health of British companies, used discriminant analysis and financial ratios. The author, adding a new variable to Altman's (1968) Original Z-Score Model, produced a new model. When this model called J-UK is compared with Z-Score Model, the prediction strength is 82.9%. ıt was identified that J-UK Model had higher accuracy than Z-Score Model in predicting financial failure.

Cındık and Armutlu (2021), in their studies, in order to predict the financial troubles of the companies in Turkey, using Altman Z-score, Revised Altman Z'-Score, Linear Discriminant Analysis, Quadratic Discriminant Analysis and Random Forest Machine Learning models, on the purpose of selecting the most effective one among the models, made analyses. In the analyses, the data of 44 taking place in BIST and of 36 small and middle-sized enterprises between the years 2013-2018 were used. As a result of these analyses, it was suggested that Forest Machine Learning Model was the most effective model for the firms in Turkey.

Duane et al. (2007), in their studies, compared Canada bankrupt models developed by Springate, Altman Z score, Ohson, and Legault and Véronneau. Although Springate, Legault and Véronneau model gave similar results to the Ohlson model, it was tested through Canada- origin firms and it was concluded that the weakest model was Altman Model.

MFA-Score is a model developed by Çolak (2019) to measure the financial failure risk and bankruptcy probability of the firms. The model is important because it is a model developed specifically for Turkey and it is possible for it to be used as a warning indicator of financial failure for Turkish firms. 230 balance sheet data of 361 different firms taking place in BIST. Among these firms, for being able to apply MDA, [the data] of 108 firms, which are successful from successful and unsuccessful 54 fiscal aspects were used. In 108 firms, to not make biased performance measurements, the data were again divided into two, a test group (27 successful and 27 unsuccessful) and a control group (27 successful and 27 unsuccessful), and tests were made.

Çolak, in the study he carried out, revised Altman Z-Score Model (1968), which is primarily accepted as an accounting–based model and is commonly used in academic studies, according to the firms in Turkey, applying MDA (Multi-Discriminant Analysis). The revised state of the Altman Z-Score model (1968) for Turkish firms is given as follows:

$$Z-Score= 1{,}06X1+1{,}17X2+2{,}59X3+0{,}23X4+0{,}13X5$$

The financial achievement predictive power of the revised Z-Score Model for one year ago was found 88.8% in the test group and 90.74% in the control group. When the original Altman Z-Score Model are applied on the same sample, the performance ratio was found 79.63% in the test group and 81.48% in the control group. The results show that the predictive power of the revised Z-Score Model is higher compared to Altman Z-Score Model.

Çolak (2019), following his study, developed MFA Score Model, using the ratios, which are suitable for the features of BIST firms and will increase achievement prediction. 7 ratios determined from 30 different financial ratios used in the literature were used in MFA Score determination in the direction of statistical and intuitional criteria.

Financial Scores Used in MFA –Score

X1= (liquid assets + security exchanges + short-term trade receivables/short-term foreign assets)

X2= Short term foreign assets /Working assets

X3=Total Debts /Equities

X4 = **E**arnings **B**efore **I**nterest, **T**axes, **D**epreciation, and **A**mortization (EBITDA)

X5=Financing expenses /Net sales

X6=Net Profit (Loss)/Net sales

X7=undistributed profits /total assets

The model obtained by means of these 7 variables selected formed as follows:

$$MFAscore = 0.24X1 - 0.14X2 - 0.03X3 + 3.76X4 - 0.72X5 + 0.20X6 + 1.14X7$$

When standardized coefficients are examined, it was identified that the basic determiners in terms of financial achievement prediction for Turkish firms were the liquidity position of the firm (acid-test ratio), total leverage, EBITDA and undistributed profits. However, it is also seen that the rates of financing expenses and short-term debts to current assets are less related to financial achievement assessment.

MFA Score accurately predicts 24 of 27 firms, which are unsuccessful from the financial point of view, in the test group and 23 of 27 firms in the control group, one year ago. However, when the firms having debt paying power, accepted successfully from the financial point of view, are evaluated, 26 firms in the test group and 27 firms in the control group are accurately predicted for one year ago. As a result, the MFA score has a successful performance of 92.6% in predicting financial failure risk for one year ago in terms of the firms in both groups. It is seen that MFA Score specific to Turkey has higher discriminative power compared to Altman's (1968) model.

AIMS AND OBJECTIVES

The aim of this study carried out, testing the effects of both the Altman Z-Score Model and MFA Model, developed by Çolak on the firm value, is to identify which model is more successful in terms of the firms taking place in the service sector in Turkey. In the study, Z-Score Model Altman made applicable later in terms of both non-public and service companies will be compared with MFA Model, developed by Çolak. From this aspect, comparing Altman Z-Score Model with MFA Model is important in terms of measuring the effects of the models on the market values of the firms and their abilities to identify financial achievement levels specific to Turkey.

METHODS

Altman Z-Score Model is an accounting-based model trying to measure the financial performance of the firm, using the data of financial tables. This model was formed for public businesses in the USA and called Altman Z-Score Model. Later, while Altman Z'-Score Model was for non-public businesses, finally, Altman Z'' Score Model was suggested for economies of developing countries (Özdemir, 2014). When a literature review associated with measuring the financial performances of the firms is made, many researchers, taking an example Altman Z-Score models, made effort to develop suitable models for their own countries. Among these efforts, the study emerging specific to Turkey is the multivariate firm assessment (MFA) model, developed by Çolak (2019). The MFA score model, different from Altman Z' Score and Altman Z'' score models, incorporate leverage ratio and financing expenses, which have great importance in terms of the firms in Turkey, as extra variables. With these variables added to MFA Score Model, it was proved that MFA Model is more successful than the Altman Z'-Score and Altman Z''-Score Models in measuring the bankrupt risk of the firms in Turkey with an achievement rate of 90%. (Eren, 2020).

DOI: 10.55643/fcaptp.1.48.2023.3971

Certainly, the primary aim of the Altman Z-Score Model and MFA Model is to introduce the bankrupt risk of the firms. However, if it is possible to use Altman Z-Score values for comparing the financial performances of the companies, in the same way, it will be also possible to use the values of the MFA model for the same purpose.

Depending on these premises, it was predicted that Altman Z-Score and MFA Score values could be an indicator of the financial performance of the firms. According to this deduction obtained, if there is a relationship between Z"-Score and MFA Score values and financial performances of the firms, it will be necessary for this relationship to affect the market values of the firms. Secondly, if the first hypothesis is valid, it will be also evaluated which of both models is significant. In order to test, this hypothesis formed, the results of the Z'-Score and MFA Model of service firms were recorded in Istanbul Stock Market and the market values of these firms were used in the study. The principal cause of that the study was carried out by means of the data of service sector firms recorded to BIST is that Altman Z"-Score Model is originally prepared for businesses in the service sector. In the previous sections, while Altman models are explained this subject has been mentioned. However, much as Altman Z" Score Model is prepared for, Altman himself stated that it was the most suitable model for the firms of developing countries. MFA Model does not have any sectorial limitations.

RESULTS

Dataset

Depending on these determinations made, using the data of the firms in the service sector in comparing two models is a quite common situation. In preparing the data used in the study, Finnet's financial analysis infrastructure was used. For being able to test the hypothesis set up the most accurately, Service sector firms, recorded to BIST, were subjected to evaluation. In addition, for being able to identify the most suitable period that is possible for the scope of study time, the data continuations of the firms recorded to BIST were examined. According to this examination, it was decided that the most suitable study period was 38 period between the 2nd quarter of the year 2012 (6 months) and the 3rd quarter of 2021 (9 months). As a result of these examinations, in the study carried out, the data of 15 firms and the financial table data of 38 quarters belonging to these firms were accepted as a dataset. The firms that are the subject of the study were shown in Table 1.

Table 1. BIST Service Sector Firms that are the subjects of the study.

AKENR	BIZIM	SELEC
AKSEN	CLEBI	TCELL
ANELE	DOBUR	TGSAS
AVTUR	ENKAI	THYAO
BIMAS	LKMNH	TTKOM

Z" score values belonging to these firms identified were calculated as shown in Formula 1 and presented in the section of Annex.

$$Z'' \text{ Score} = 6.56X_1 + 3.26X_2 + 6.72X_3 + 1.05X_4 \quad (1)$$

According to Altman Z" Score calculation,

X_1: Business capital / Total Assets

X_2: Undistributed Assets / Total Assets

X_3: Profit before Interest and tax / Total Assets

X_4: Book Value of Equities / Total Debt.

MFA score calculation formula (2) previously explained is presented as follows: MFA scores of the firms specified in Table 1 were also calculated according to this formula.

$$\text{MFA score} = 0{,}44M_1 - 0{,}12M_2 - 0{,}47M_3 - 0{,}13M_4 + 0{,}45M_5 + 0{,}29M_6 + 0{,}49M_7 \quad (2)$$

M_1 = (Liquid Assets+ Security Exchanges + Short Term Trade Receivables)/Short Term Liabilities

M_2 = Short-Term Liabilities/Working Assets

M_3 Total Liabilities/Equity

M_4 = Financing Expenses/Net Sales

M_5 = Profit Before Interest, Depreciation and Tax/Total Assets

M_6 = Net Year End Profit/Net sales

M_7 = Undistributed Profit Total Assets

In the formed dataset, because of the fact that it contains both time and cross-sectional values, the dataset was transformed into a panel dataset on the scale of 38x11. Although making an analysis on panel datasets partly includes similarities to time series, it also includes differences in many aspects. The most important one of these differences and the element that is necessary to be studied the most is the horizontal cross-section. Other than horizontal cross-section dependence, in addition, studying homogeneity are quite important for panel data analyses. Depending on the solution of these two elements, analyses to be made will also be different. For a better understanding of the issue, the subjects of the horizontal cross-section dependence and homogeneity will be shortly explained in the following section.

Horizontal Cross-Sectional Dependence

The panel data structure, as mentioned earlier, consists of combining cross-section and series. If a cross-sectional series exhibits behaviour in the direction of commonly acting, a correlation emerges between cross-sectional series and this case is named horizontal sectional dependence. Without considering a correlation i.e. the study of horizontal cross-sectional dependence between cross-sectional series, the results of analyses to be made are quite different and can mislead the researcher Breusch and Pagan, 1980; Peseran, 2004; Altındaş and Mercan, 2015). According to the result of horizontal sectional dependence, the analyses which are necessary will be also different.

In order to study, many models were developed. These models are Breusch-Pagan LM (1980) test, Peseran CD (2004) and Peseran, Ullah and Yamagata (2008) NLM test. The methods to be used for identifying the suitable one from these tests is basically as follows: If the time series (T) is bigger than the cross-sectional series (N), Breusch-Pagan LM (1980) test must be chosen; if N > T, Peseran CD (2004) Test;) and if N and T reach very big values, Peseran, Ullah and Yamagata (2008) NLM tests. In Pesaran CD (2007) horizontal sectional dependence test, the correlation between residuals obtained as a result of ADF (Augmented Duckey Fuller) regression is calculated (Tatoğlu, 2017).

For being able to calculate the Pesaran CD test,

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

$$\hat{\rho}_{ij} = \hat{\rho}_{ji} = \frac{\sum_{t=1}^{T} e_{it}e_{jt}}{\left(\sum_{t=1}^{T} e_{it}^2\right)^{1/2}\left(\sum_{t=1}^{T} e_{ij}^2\right)^{1/2}} \quad (3)$$

where, e_{it} and e_{ij} are residuals obtained as a result of regression and represent the correlation between $\hat{\rho}_{ij}$ i and j. Hypotheses formed for the test made are (Pesaran, 2007):

H_0: There is no correlation between cross-sections.

H_1: There are correlations between cross-sections.

In this study carried out, there are our three variables in the size of N = 111 and T= 38 as Z", MFA and firm value. The results of the Peseran CD (2004) test and other horizontal cross-sectional dependence test were presented in Table 2.

Table 2. The Results of Horizontal Cross-Sectional Test.

Test	Market Value			Z" Score Value			MFA Score Value		
	Statistic	d.f.	Prob.	Statistic	d.f.	Prob.	Statistic	d.f.	Prob.
Breusch-Pagan LM	229992,0	840	0.0000	242424,0	840	0.0000	236208,0	840	0.0000
Pesaran CD	4.795,748		0.0000	4.923,657		0.0000	2060.211		0.0000
P. U. Y. NLM	2.005,975		0.0000	2.117,474		0.0000	486.0123		0.0000

DOI: 10.55643/fcaptp.1.48.2023.3971

When the results of three horizontal sectional dependence carried out on the variables of Z"–Score, MFA Score and Firm Market Value that are the subject of the study are examined, depending on the result of $p < 0.05$ for each test, while H0 is rejected, H1 is not rejected. According to these acceptances, it was concluded that the variables have a correlation in their own horizontal cross–section and that horizontal sectional dependence cannot be rejected.

In panel data studies, an important subject that is necessary to be examined after horizontal sectional dependence is the homogeneity of data.

Homogeneity Test

In panel data studies, it is an important test showing how the other cross-sectional variables are affected in the face of variation occurring variation on any of the variables on the cross-sectional level. If a variation in any of the cross–sectional variables also shows similar effects on the other cross-sectional variables, we express that the data structure is homogenous, otherwise, it is heterogeneous. (Kar, Ağır and Türkmen, 2018). In addition, whether or not panel data is homogenous plays important role in the preference of analyses to be made later.

In this study carried out, using the Hsiao (1986) homogeneity test, the homogeneity of the panel dataset was tested. In the Hsiao homogeneity test, three hypotheses as H1, H2 and H3 are formed. While H1 and H2 hypotheses accept that model coefficients are homogenous, the H3 hypothesis accepts that confidents are partly homogenous (Turgut and Okyay, 2019). The results of the Hsiao homogeneity test made on the variables of these were shown in Table 3.

Table 3. The Results of the Hsiao Homogeneity Test.

H1 = Null Hypothesis: the panel is homogeneous Alternative Hypothesis: H2		
H2 = Null Hypothesis: H3 Alternative Hypothesis: the panel is heterogeneous		
H3 = Null Hypothesis: the panel is homogeneous Alternative Hypothesis: the panel is partially homogeneous		
Hypotheses	**F-Stat**	**P-Value**
H1	0.000000	1.000000
H2	0.000000	1.000000
H3	0.000000	1.000000

In the results of the Hsiao homogeneity test, since $p < 0.05$, the homogeneity of the panel dataset cannot be clearly obtained. According to the results of the horizontal cross-sectional dependence and homogeneity test, for unit root tests that is the next step, it will be decided which test will be used.

In case there is no horizontal cross-sectional dependence, while 1st generation unit root tests can be applied, in case there is horizontal cross-sectional dependence, 1st generation unit rot tests can give misleading results. In case there is horizontal cross-sectional dependence, Taylor and Sarno (1998) MADF, Breuer et al. (2001) SURADF and Pesaran (2007) CADF (CIPS) unit root tests that are 2nd generation unit root tests are recommended. Among these tests, in the cases of N>T and T<N, the CPS test gives the most reliable results. (Küçükaksoy ve Akalın, 2017). Also, in this study carried out, depending on the reasons specified, the CPS unit root test was preferred.

The CADF test developed by Pesaran (2007) was developed from a cross-sectional point of view, the data analyses under horizontal cross-sectional dependence give reliable results, while both T>N and de N>T. Another feature of this test is that it is a heterogeneous test. The Pesaran CADF panel unit root test is based on the model given below (Küçükaksoy and Akalın, 2017). In case there is no correlation, the panel data model is like in Formula 4.

$$Y_{it} = (1 - \emptyset_i)\mu_i + \emptyset_i Y_{i,t-1} + u_{it} \quad (4)$$

when f_t is accepted as an unobservable factor and if u_{it} has a single factor structure, u_{it} is expressed I as shown in Formula 5 (Tatoğlu, 2017):

$$u_{it} = \gamma_i f_t + e_{it} \quad (5)$$

When u_{it} is put in its place in the model, the new model will transform into the form seen in Formula 6.

$$\Delta Y_{it} = \alpha_i + \rho_i Y_{i,t-1} + \gamma_i f_t + e_{it} \quad (6)$$

It is necessary to make corrections in the form of

$\Delta Y_{it} = Y_{it} - Y_{it-1}$, $\alpha_i = (1 - \emptyset_i)\mu_i$ ve $\rho_i = (1 - \emptyset_i)$

Pesaran, taking the arithmetic mean of each series, formed H_0 and H_1 hypotheses with CIPS values.

$$CIPS(N,T) = \frac{\sum_{i=1}^{N} t_i(N,T)}{N} \quad (7)$$

H_0: There is a unit root.

H_1: There is no unit root.

The results of the unit root test realized, depending on theoretical explanations, are shown in Table 4.

Table 4. Pesaran (2007) The results of CIPS Unit Root Test. Note: *: significant in 99% confidence interval.

Firma Value CIPS* = -3.645 N, T = (111,38)				**MFA CIPS* = -4.314 N, T = (111,38)**			**Z'' CIPS* = -2.854 N, T = (111,38)**		
	10%	5%	1%	10%	5%	1%	10%	5%	1%
Critical values at	-2,010	-2,060	-2,140	-2,010	-2,060	-2,140	-2,010	-2,060	-2,140

As also shown in Table 4, since the CPS value is bigger than the critical value of 1% for both variables, H_0 is rejected and it is accepted that the variables do not have any unit root.

Since H_0 is rejected for Z'', Z'' does not contain a unit root at the level of (0) level.

Since H_0 is rejected for firm value, firm value does not contain unit root any unit root at the level of I (0).

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

Panel LS Test

Panel LS tests are an econometric model used in case each variable is stationary at the level in the studies formed by panel data. However, in the selection of the sort of analysis to be used, that the variables do not contain unit root is not a single decision criterion. Other than unit root tests, horizontal cross-sectional dependence and homogeneity of coefficients of the variables is important. In this study carried out, the presence of a correlation between the horizontal cross-section of the variables was identified in the previous sections. Depending on these determinations made, on the homogeneous panel data that has horizontal cross-sectional dependence, PDOLS (Panel Dynamic Least Squares) model, among second-generation analyses, can be used. (Tatoğlu, 2017). PDOLS analysis comes to our face as a long-term predictor and adds the anticipant and lagged values of the variables to the model to eliminate the cross-sectional correlation effect and internal feedback directed to the independent variable disappears (Çetin et al., 2014). PDOLS analysis model is shown as follows (Kao and Chiang, 2001: Yıldırım, 2020):

$$Y_{it} = \alpha_i + x_{it}\beta + \sum_{j=-q}^{q} c_{ij}\Delta x_{it} + v_{it} \quad (8)$$

c_{ij}, added to the model formed, is the coefficient of the explanatory variables, taking their first differences, the anticipant and lagged values.

For being able to be made Panel LS test, it is necessary to study the model from the fixed effects, random effects or pooled effects. For being able to identify the effect on the model, it is necessary to make Chow(F) and Breush-Pagan LM tests. Without introducing the theoretical explanations of these tests, the hypotheses of each test were shown in Table 5.

Table 5. Effect Hypotheses.

Hausman Test	**Chow(F) Test**	**Breush-Pagan LM Test**
H_0: There is a random effect.	H_0: There is a pooled effect.	H_0: There is a pooled effect.
H_1: There is a fixed effect.	H_1: There is a fixed effect.	H_1: There is a random effect.

DOI: 10.55643/fcaptp.1.48.2023.3971

Hypotheses formed were tested on both the horizontal cross-section plane and time plane and test results were shown in Table 6.

Table 6. The Results of the Effect Test.

	P değeri	H_0	H_1	Effect
Hausman Test	0,9947	Accept	Reject	Random Effect
F Test	0,9989	Accept	Reject	Pooled Effect
B-P LM Test	1,0000	Accept	Reject	Pooled Effect

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

As a result of all tests made, the following model is suggested, in which firm value is the dependent variable and Altman Z"- Score value is an independent variable.

$$Ln(Firm\ Value)_{it} = \alpha_i + Z''_{it}\beta + \sum_{j=-q}^{q} c_{ij}\,\Delta Z''_{it} + v_{it} \quad (9)$$

Table 7. Firm Value and' 'PDOLS Test Results. Note: *: significant at the significance level of 1%.

Dependent variable as firm value				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
Z"	0.363245*	0.004756	81.65478	0.0000
R-squared	0.847458	Adjusted R-squared		0.761425

According to the POOLS analysis result, since P<0,05, Z" affects the variable of Firm Variable and the hypothesis is not rejected. In addition, the value R2 is examined in the analysis made, the significance level of the model formed was identified as 0.847, and the significant level can be accepted as quite high. Finally, it is understood that Altman Z" model affects firm value at the rate of 0.36. Depending on all results obtained, although Altman Z" model is formed to measure the financial failure of the firms, it was also demonstrated that it could be used to predict the increase or decrease in firm value in the long term.

As a result of all tests made, the following model was suggested, in which firm value is a dependent variable and Altman Z" score value is an independent variable

$$Ln(Firm\ Value)_{it} = \alpha_i + MFA_{it}\beta + \sum_{j=-q}^{q} c_{ij}\,\Delta MFA_{it} + v_{it} \quad (10)$$

Table 8. Firm Value and MFA PDOLS Test Results. Note: *: significant in the confidence level of 1%.

That dependent variable is the firm value				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
MFA	0.519412*	0.006247	65.65478	0.0000
R-squared	0.8121457	Adjusted R-squared		0.724587

According to the PDOLS Analysis result, since P < 0.05, the hypothesis that MFA affects the variable of firm value is rejected. In addition, when the R2 value of the analysis made is examined, the significance level of the model formed was identified as 0.812, and it is accepted that this significance level is quite high. In addition, it is understood that the MFA model affects firm value at the rate of 0.52. Depending on all results obtained, although the Altman MFA model is formed to measure the financial failure of the firms, it was also demonstrated that it could be used to predict the increase or decrease in firm value in the long term.

It is understood that both of Z" and MFA score models have an effect on the firm value, however, although R2 values are quite close to each other for both models, their effect confidents are different from each other. It was identified that the

effect of MFA value on firm value was higher than that of Z'' score value. Depending on these determinations, although both models are valid and specific to Turkey, it is understood that the effect of MFA score values on firm value is higher.

DISCUSSION AND CONCLUSIONS

Although the studies using multivariable discriminant analysis directed to measuring financial achievements and performances in the literature have begun in the 1960s, the first studies made were mostly applied in developed countries. Question marks about whether or not the models formed in the countries having the developed economic and financial structure will work later according to the economic and financial development in the same way have emerged. The applicability of these models on the markets of developed, developing and less developed countries was generally tested. In the study, the revised Altman Z'–score model, which can be applied to public companies as well as non-manufacturing companies, and MFA Model, developed by Çolak, are compared.

It was identified that there was a relationship having a high significance level between Altman Z'' score value and firm value. Between two variables, according to the PDOLS model formed, in which firm value is the dependent variable and Z'' value is the independent variable, an increase of 1 unit in Z'' score value causes an increase of 0.363 units in firm value. PDOLS Analysis, formed between Altman Z' score value and firm value were also formed MFA and Firm Values, and a relationship having a high significance degree was identified between the MFA score model and firm value. According to PDOLS analysis results, firm value shows an increase of 0.519 unit compared to an increase of 1 unit in MFA score value. Depending on this determination:

1. Altman Z'' and MFA score models are valid for the service sectorial firms, recorded Istanbul Stock Market, other than financial firms.
2. Altman Z'' and MFA score value increases make a contribution to the increase of firm values in the service sector.
3. Following Altman Z'' and MFA score values will make a contribution to long-term investment decisions.
4. Since Altman Z'' and MFA score values are calculated as a result of accounting results, it is necessary for the service sectorial firms recorded to Istanbul Stock Market to meticulously prepare their records. Furthermore, in the period when the financial tables of these firms are declared, it will be more appropriate for them to Altman Z'' and MFA score values.
5. In predicting the firm values of the service sector, the MFA score model is a more effective model than Altman Z'' score model in Turkey.

Depending on these results, in the next study, it will be appropriate to prepare an index through Altman Z'' and MFA values for market investors.

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DOI: 10.55643/fcaptp.1.48.2023.3971

Ібрагім Емре Гоктюрк, Хусеїн Сердар Ялцінкая

ВИКОРИСТАННЯ МОДЕЛЕЙ БУХГАЛТЕРСЬКОГО ОБЛІКУ ДЛЯ ВИМІРЮВАННЯ ФІНАНСОВИХ РЕЗУЛЬТАТІВ: ПОРІВНЯННЯ ОЦІНОК АЛЬТМАНА ТА МУЛЬТИФАКТОРНОГО АНАЛІЗУ (МФА)

Метою цього дослідження є спроба виявити наявність зв'язку між результатами індексів оцінок Альтман Z'', моделями оцінки МФА та ринковою вартістю фірм і визначити, яка модель є більш ефективною. Порівняння двох моделей, які є предметом дослідження, здійснювалося на прикладі сфери обслуговування. Основною причиною надання переваги сфері послуг є те, що модель оцінки Альтман Z'' була сформована шляхом першої модифікації оригінальної моделі оцінки Альтман Z'' для фірм у секторі послуг США. Однак пізніше було визначено й рекомендовано використовувати цю модель і для фірм країн, що розвиваються. Мультифакторна модель (модель МФА) – це модель, розроблена спеціально для Туреччини. У дослідженні виявлено, що за допомогою цих моделей можна вимірювати не тільки фінансові невдачі, які турбують фірми, але і їхні можливі досягнення в майбутньому. У контексті цього завдання здійснювалося порівняння обидвох моделей. Акцентовано, що для середньострокових і довгострокових інвесторів доцільно вводити науково обґрунтовану інформацію про підтримку інвестицій. Крім того, у статті наголошено, що застосування цих моделей сприятиме формуванню набору даних, достатнього для ухвалення рішень усіма зацікавленими сторонами у фірмі, за винятком інвесторів. Для того щоб мати можливість досягти привабливих цілей, у дослідженні були використані BIST у сфері послуг. Також були використані дані про спільну інтеграцію панельних часових рядів і, як наслідок, стало зрозуміло, що ефективність упровадження моделі прогнозування банкрутства (Альтман Z'') склала 36,3 % від вартості фірми за один період, тоді як модель МФА – 51,9 % від вартості фірми за відставання в один період. Відповідно до цього було виявлено, що дані моделі МФА були більш ефективними для прогнозування вартості фірми.

Ключові слова: базові моделі бухгалтерського обліку, фінансові рахунки, модель Альтман Z, модель мультифакторного аналізу МФА, сервісний бізнес

JEL Класифікація: G10, M40, M41