

Evaluation of Credit Risk based on Financial Efficiency of Companies accepted in Tehran Stock Exchange

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Abstract: This paper seeks to describe the relation between variables (dependent and independent) through using statistical (descriptive) tests. The present paper is an applied research in terms of objective and a correlative – descriptive research in terms of nature of subject; also it is an ex post facto research. To gather data, both library and filed study methods have been used. Statistical data pertaining to the companies have been collected by information published by Tehran Stock Exchange via existing programs. To analyze information, descriptive and inferential data has been applied. In the descriptive data, descriptive information of the sample and diagrams of the variables have been used; and in the inferential data, data envelop analysis (DEA) method has been applied to assess function and efficiency of the companies. Ordinary least squares method has been finally used to determine the relation of variables. The statistical universe comprises investment companies accepted in Tehran Stock Exchange during a five-year period from 2006 to 2010. To select the sample, such criteria as continuity of investment during the research period, standard information filtering, and entrance into the Stock Exchange before 2005 have been considered. The results of this paper reveal that the relations of variables namely total tax revenue divided by total assets (Rev/A), total tax revenue divided by equity (Rev/E), and total debt divided by total assets (DEBT/A) with efficiency are significant and the rest of variables do not have a significant relationship.

[Mohammadreza Nourbakhshian. **Evaluation of Credit Risk based on Financial Efficiency of Companies accepted in Tehran Stock Exchange.** *Life Sci J* 2013;10(12s):940-948] (ISSN:1097-8135).
<http://www.lifesciencesite.com>. 153

Key words : Efficiency, financial indices, econometrics, DEA

1. Introduction

Improvement of capital market share in financing the economic projects of the country has no doubt been one of the most essential objectives and concerns of the capital market managers. Quantitative and qualitative increase of tools, entities, and financial markets in the recent years besides increase in the participants share indicate the endeavor of the market authorities to improve its position in this area. Improving transparency and protecting rights of investors in the capital market are among the main missions and priorities in the country capital market which plays an important role in achieving the above mentioned goals. One of the main factors of transparency in this market is creating mechanism of identifying the existing risks and familiarity of investors with risks and using them in analysis and investment decisions (Iscoe, I., et al., 2012). One of the main challenges of the current capital market of the country is lack of detection, determination and disclosure of credit risks of financing tools and companies and lack of sufficient familiarity of investors with the existing risks. It seems that now by entering into the world of risk, it is time to engage this vital factor in the investment decisions (Gourio, F., 2012). There is no doubt that the gate of entrance for investors into the vast arena of risk is rating agencies which play an important role in measuring and introducing risk different parameters. The experience

of emerging countries depicts that these countries have focused abundant attentions on establishment of rating agencies and have undertaken many endeavors in using services of these agencies by micro and institutional investors in order to develop the capital market comprehensively. For example, India established CRISIL rating Institute in 1986 and established three other agencies in 1992, 1994, and 2007 consistent with the growth of capital market. Malaysia established RAM Institute in 1990 and MARK Institute in 1994 and removed a major part of problems existing in this field. Also china experience in establishing Dagong and Chegxin Rating Institutes in 1995 and 2006 and Brazil experience in establishing SR Ratings in 1993 can be mentioned, they founded columns of transparency improvement through measuring credit risk in their capital markets (Viorica, I., 2012). At the present juncture, except for Iran, Afghanistan, Tajikistan, and Yemen in the Middle East, all other countries either have established rating agencies or enjoy services of international rating agencies. Two recent international financial crises, namely ASEAN countries crisis from 1996 to 1999 and credit crisis of the United States and Europe from 2007 to 2010, revealed the role and position of these rating agencies in evaluating risks of issued securities and their prediction power in dishonoring the securities more than before. The experience of recent financial crisis reflects that a high percent of dishonors

during these years pertains to those securities which have had speculative grade (Jacobs, M., 2013). Nowadays in most emerging markets anyone who wants to enjoy financing through capital market must be ranked and have a determined credit rank. This is right for both issuance of securities with fixed revenue and companies accepted in Stock Exchanges and OTC markets. This matter is prevalent in advanced financial markets so that recently in the rules enacted by European Parliament in 16 January 2013 there are provisions based on which all public securities must receive credit rank from at least two valid rating agencies. Rules enacted in these country reflect the importance of attention to the risk issue (Vishnu, S., et al., 2013).

This paper seeks to design a model for assessing credit risk of companies and in the other words explaining the relation of credit risk and firm efficiency by using data envelop analysis (DEA) model and ordinary least squares method. In so doing, firm efficiency is first specified by using DEA model and pre-determined input and output variables, and (technical) efficiency score as the dependent variable is entered into OLS model and independent variables are important and known indices of credit risk.

2. Literature Review

Some effective indices on firm credit risk including liquidity ratio, the ratio of total debts to total assets, ROA ratio, ROE rate, ratio of total assets flow, ratio of equity to total assets (equity ratio), margin to sales, and net profit to sales are considered as the independent variables of OLS model. The main question of this paper is that how one can measure the relation of important indices of credit risk of Tehran Stock Exchange investment companies with their efficiency.

2.1 Theoretical Literature

To achieve the same concepts in the minds of those interested in this field of study, technical words and terms are defined.

Credit risk (conceptual): it is loss probability due to lack of capability for refunding debts or reduction of firm credit.

Credit risk (operational): it is measured in this paper by using its indices namely liquidity ratio, debt ratio, return on assets ratio, return on investment rate, total assets flow ratio, equity ratio, and margin to sales (Psillaki, A., 2010).

Output variable (conceptual): it is resulted from production system operation and supplied as goods or services (Psillaki, A., 2010).

Output variable (operational): in this paper, value added and company revenue are regarded as outputs (Psillaki, A., 2010).

Input variable (conceptual): it is all the resources required for production of the related goods or services (Psillaki, A., 2010).

Input variable (operational): in this paper, return on investment and number of man power are regarded as inputs (Psillaki, A., 2010).

Efficiency (conceptual): it is the ratio of the actual efficiency to the expected (standard or determined) efficiency, or in the other words efficiency is the ratio of the undertaken activity to the activities that must be undertaken (Musavian and colleagues, 2010).

Efficiency = (outputs) total weight of outputs / (inputs) total weight of inputs

If inputs are $x_{1j}, x_{2j}, \dots, x_{mj}$ and outputs are $y_{1j}, y_{2j}, \dots, y_{sj}$, then

Efficiency = $U_1 Y_1 + U_2 Y_2 + \dots / V_1 X_1 + V_2 X_2 + \dots$

V = input weight U = output weight

PR/A: profits before interest and tax divided by total assets (first index of credit risk)

Assets: total assets of the company

Rev/A: total operating revenue divided by total assets (second index of credit risk)

Rev/E: total tax revenue divided by equity (third index of credit risk)

Revenue: total tax revenue

Equity ratio: equity

Debt/A: total debt to total assets ratio (fourth index of credit risk)

Debt/E: total debt to equity ratio (fifth index of credit risk)

Debt: total debt of companies

Tan/A: the ratio of fixed tangible assets over total assets (sixth index of credit risk)

Tan/E: the ratio of fixed tangible assets to equity (seventh index of credit risk)

Tangible: total fixed tangible assets

INT/A: the ratio of intangibles to total assets (eighth index of credit risk)

INT/E: the ratio of intangibles to equity (ninth index of credit risk)

Intangibles: total intangible assets

WKC/A: the ratio of working capital to total assets (tenth index of credit risk)

WKC/E: the ratio of working capital to equity (eleventh index of credit risk)

Working Capital: working capital (Psillaki, A., 2010).

Webster Dictionary has defined risk as "being subjected to danger" (Webster's, 1981). (Berger, A.N., et al., 2006) sometimes risk is defined as an unfavorable change in the actualized returns. In the other words, only downside changes of returns are considered risk. (Raei, et al., 2004) the concept of risk is prevalent in the financial area as market participants ask about the risk level in the first encounter with any securities (Markowitz, H., 1952). If we replace the

concept of returns by the expected returns, the concept of risk may be defined by variance of returns (Treacy, W.F., 1998). Systematic process portfolio management embraces five stages namely, determining goals of investment, assets allocation strategies, stock portfolio management strategies, stocks selection, measurement and evaluation of performance. (Crouhy, M., et al., 2006) non-payment risk is created as a result of changes in the factors that form credit quality of the assets. Credit risk is the probability of delay or doubt in refund or lack of refund of the interests of financial facilities provided for the applicants. (Rom, B., 1993) in post-modern portfolio theory, a specific transparent differentiation of "unfavorable risk" occurs for the evaluation index. In this theory, only "unfavorable fluctuability" and "favorable fluctuability" among fluctuations below the target rate are considered risk. All the returns over this target are called lack of confidence. (Janani, M. H., 1998) to measure systematic and non systematic risks, single-factor models, Capital Asset Pricing Model, multi-factor models, and Arbitrage Pricing Model can be applied. (Hagen, R., 2005) he presented portfolio non systematic risk which can be calculated by two ways. The first method that is an inefficient method is portfolio co-variance matrix. In the second method, since the calculated systematic risk is accurate and real technically and in the above mentioned model no hypothesis has been considered for calculating portfolio total risk, below relation is considered. CAMP total risk in Markowitz model – total risk in CAPM model = real non systematic risk – non systematic risk in model (Saunders, A., 2002).

2.2 Research Background

Ghodsipour and colleagues (2012) have evaluated credit risk of loan-receiving companies by using fuzzy hierarchical analysis and high-grade synthetic neural network. The results can predict credit risk by 84% accuracy. Mirzaei and colleagues (2011) have studied a random sample comprising 455 (323 trustworthy customers and 132 untrustworthy customers) law firms which had received credit facilities from Iran Bank Melli, Tehran branches, in 2008 by using logistic regression method. First 39 explanatory variables including qualitative and financial variables were identified by 5c method and finally they selected 11 variables which had a significant effect on the credit risk and differentiation between trustworthy and untrustworthy customers and fitted the final model by them. Sepehrdoust and Moti'ei (2011) in a paper titled as "the role of intellectual capital in the performance of Stock Exchange companies" studied the relation of intellectual capitals with operational cash flows and net value added as the indices of evaluating performance of the companies accepted in Tehran

Stock Exchange during 2004-2007. Ezazi and colleagues (2011) in a paper titled as "the relation of company size with returns and risk in Tehran Stock Exchange" analyzed the relation of company size with the rate of returns and risk in companies accepted in Tehran Stock Exchange. Falah Shams and Mahdavi (2010) identified effective variables on the credit risk based on data pertaining to the natural customers of Iran Khodro Leasing Company facilities from 2002 to 2005 and used five variables namely, net monthly income of the applicant, facilities period, facilities amount, net monthly income of the guarantor, and work experience. Safari and colleagues (2010) carried out a research aimed at identifying effective factors on credit risk-taking and presenting a model for rating legal customers of Bank Tejarat in Tehran by using data envelop analysis method. The results revealed that 25 companies were quite efficient. Also testing coefficient significance hypothesis cleared that all indices except for "equity to total assets" are in the expected paths and are statistically significant at the level of 95% confidence. Mehrara and colleagues (2009) carried out a research aimed at modeling credit risk measurement and validation of customers in Parsian Bank by logistic and probit regression and Smart GMDH Neural Networks model. Masihabadi and Vahedian (2009) examined validity of the results of data envelop analysis technique in credit rating by using information pertaining to two groups of manufacturing companies of Stock Exchange and seven selected financial ratios. Hemati and Mohebinejad (2009) evaluated the effect of macro-economic variables on banks credit risk. The results revealed that fluctuations and difference of credit risk are not remarkable among different banks and a major part of bank credit risk fluctuations is resulted from changes in the country macro-economic situation over time. Khalili and colleagues (2009) have studied the effect of environment risks, company strategy and capital structure on the firm performance in the petrochemical industry. The results suggested that the model variables including environment risks, company strategy, and capital structure influence the firm performance. Psillaki and colleagues (2010) evaluated credit risk based on firm performance by using data envelop analysis and logistic regression. Premachandra and colleagues (2009) in a paper titled as "data envelop analysis as a tool for bankruptcy assessment: a comparative study with logistic regression technique", compared differentiation and identification of bankrupt and non-bankrupt companies by using two techniques namely data envelop analysis and logistic regression.

3. Research Methodology

This paper is a descriptive research and an applied research in terms of objective and a correlative

research in terms of subject nature. Also it is an ex post facto research. To gather data, two library and field study method have been used. Also statistical data of companies has been gathered by information issued by Tehran Stock Exchange and using existing programs (Rahavard Novin).

3.1 Statistical Universe

All the companies accepted in Tehran Stock Exchange are classified into nine industries one of which is financial intermediation industry. The statistical universe of this paper comprises investment companies accepted in Tehran Stock Exchange within a five-year period from 2006 to 2010. Below criteria are considered when selecting the sample.

- 1) Companies which have been continually active during the research period and are investment corporate.
- 2) Standard information has been filtered.
- 3) Date of their entrance into Stock Exchange must be before 2005.

3.2 Sample Volume and Sampling Method

With regard to the mentioned criteria, the number of samples is reduced to 21 companies. So the statistical sample of this paper is identical to the statistical universe in terms of the mentioned criteria and there is no need to the sampling method.

3.3 Research Hypotheses

This paper aims at studying efficiency of member companies in Tehran Stock Exchange (with mentioned conditions) by some financial indices. So the main hypotheses are as per below.

- 1) There is a significant relation between profit before interest and tax divided by total assets (PR/A) and efficiency of companies.
- 2) There is a significant relation between total tax revenue divided by total assets (Rev/A) and efficiency of companies.
- 3) There is a significant relation between total tax revenue divided by equity (Rev/E) and efficiency of companies.
- 4) There is a significant relation between total debt to total assets (DEBT/A) and efficiency of companies.
- 5) There is a significant relation between total debt to equity (DEBT/E) and efficiency of companies.
- 6) There is a significant relation between fixed tangible assets to total assets (Tan/A) and efficiency of companies.
- 7) There is a significant relation between fixed tangible assets to equity (Tan/E) and efficiency of companies.
- 8) There is a significant relation between total intangibles to total assets (INT/A) and efficiency of companies.

9) There is a significant relation between total intangibles to equity (INT/E) and efficiency of companies.

10) There is a significant relation between working capital to total assets (WKC/A) and efficiency of companies.

11) There is a significant relation between working capital to equity (WKC/E) and efficiency of companies.

12) By using integrated DEA and least squares regression model, an efficient model can be obtained for evaluation of companies' credit risk.

3.4 Conceptual Model

The model criteria and indices were derived and introduced in the last part, and figure 1 depicts the conceptual model.

4. Findings

First according to the hypotheses and goals of the research, companies efficiency (technical) is determined by DEA Model in constant return to scale (CRS) and then after analysis of descriptive statistics of the variables, ordinary least squares econometrics method is estimated.

Table 1-Efficiency summary with constant return to scale assumption

EFFICIENCY SUMMARY	
DMU	Rate
1	0.164
2	0.229
3	0.288
4	0.634
5	0.163
6	0.314
7	0.105
8	0.237
9	0.285
10	0.099
11	0.162
12	0.235
13	0.281
14	1.000
15	0.502
16	0.410
17	0.269
18	0.603
19	0.122
20	0.084
21	0.033
Mean: 0.296	

Source: research finding

Table 2- The results of Dickey – Fuller unit root test for efficiency

Null Hypothesis: efficiency has a unit root			
Exogenous: Constant			
Lag Length: 0 (Automatic based on SIC, MAXLAG=4)			
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.385980	0.0241
Test critical values:	1% level	-3.308546	
	5% level	-3.020686	
	10% level	-2.650413	
*MacKinnon (1996) one-sided p-values.			

The t-statistic value is (3.385980) less than estimated critical values (at all levels of 1%, 5%, and 10%). So, one can conclude that this variable is reliable. To shorten the results, table 3 presents the summary of test results for the model time series for all variables.

Table 3- The results of Dickey – Fuller test for time series data

Variable	Dickey-Fuller statistic	MacKinnon maximum critical value	Result	Degree
(Performance)	-3.39	-3.31	Reliable	1(0)
(PR/A)	-3.11	-3.10	Reliable	1(0)
(Rev/A)	-4.27	-3.81	Reliable	1(0)
(Rev/E)	-4.03	-3.81	Reliable	1(0)
(DEBT/A)	-5.01	-3.81	Reliable	1(0)
(DEBT/E)	-6.59	-3.92	Reliable	1(0)
D(Tan/A)	-3.88	-3.83	Reliable	1(1)
DD(Tan/E)	-5.53	-3.96	Reliable	1(2)
D(INT/A)	-4.30	-3.83	Reliable	1(1)
(INT/E)	-4.72	-3.83	Reliable	1(0)
D(WKC/A)	-3.84	-3.83	Reliable	1(1)
D(WKC/E)	-5.05	-3.86	Reliable	1(1)

4.4 Model Estimation by OLS Method

Having proved all variables reliability, the research main model including dependent, independent, and control variables is estimated. Software output depicts that the coefficients of the variables Rev/A, Rev/E, DEBT/A are significant and the rest ones are not significant. Table 4 presents the test results.

Table 4- OLS model estimation

Dependent Variable: Efficiency				
Method: Least Squares				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
PR/A	0.001797	0.006468	0.277781	0.7875
Rev/A	0.001949	0.000872	2.235259	0.0522
Rev/E	0.012880	0.000642	20.04873	0.0000
DEBT/A	-0.034283	0.023339	-1.468902	0.1759
DEBT/E	0.019423	0.003703	5.245232	0.0005
Tan/A	-0.032567	0.069054	-0.471626	0.6484
Tan/E	0.049216	0.028647	1.718056	0.1199
INT/A	-0.000222	0.006049	-0.036725	0.9715
INT/E	0.002318	0.002508	0.924287	0.3795
WKC/A	0.008656	0.007960	1.087530	0.3051
WKC/E	0.007586	0.004979	1.523548	0.1620
C	0.033803	0.013110	2.578351	0.0298
R-squared	0.929677	Mean dependent var		0.3048
Adjusted R-squared	0.899282	S.D. dependent var		0.1198
S.E. of regression	0.003210	Akaike info criterion		-8.3497
Sum squared resid	9.27E-05	Schwarz criterion		-7.7529
Log likelihood	99.67208	Hannan-Quinn criter.		-8.2202
F-statistic	25.32845	Durbin-Watson stat		2.2107
Prob(F-statistic)	0.000000			

The results of model estimation and other tests and calculations indicate that,

- 1) Value of t-statistics and its probability suggest significance of explanatory variables (Rev/A, Rev/E, DEBT/A) at the level of 95%. The rest variables do not have a significant relation with efficiency.
- 2) R^2 statistic demonstrates that approximately 93% of changes in the dependent variable are explained by the model explanatory variable and this indicates high explanatory power of the model.
- 3) High value of F statistic (25.33) indicates significance of the whole regression.
- 4) Durbin – Watson statistic equaling 2.21 in the model rejects the assumption of correlation among the model components.
- 5) Coefficients of the explanatory variable show that,
 - By one unit increase in Rev/A variable, efficiency increases by 0.19%.
 - By one unit increase in Rev/E variable, efficiency increases by 2.3%.
 - By one unit increase in DEBT/A variable, efficiency increases by 1.9%.

After model estimation, the accuracy of the results and coefficients must be determined by econometrics and regression tests.

4.5 Residual Reliability Test

Table 5 presents the software output for this test.

Table 5- Dickey – Fuller test for residual

Null Hypothesis: RESID has a unit root				
Exogenous: Constant				
Lag Length: 0 (Automatic based on SIC, MAXLAG=4)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-5.619279	0.0002
Test critical values:	1% level		-3.808546	
	5% level		-3.020686	
	10% level		-2.650413	
*MacKinnon (1996) one-sided p-values.				

With regard to Dickey – Fuller statistic of residual that is less than the critical value, it can be concluded that residual or error is reliable in all levels and estimation is co-integrated and regression is real.

4.6 Ramsey Test Estimation

This test is among the most valid tests for model structural stability and has been designed for investigating the error of explaining regression model. The outputs of this test are F statistic and log likelihood ratio and the related probabilities. Table 6 presents the results of this test.

With regard to the values of F statistic (0.336) and log likelihood ratio (0.865) and their probabilities (0.1778 and 0.035) and by comparing these values with chi-square value, H_0 hypothesis indicating the model structural stability cannot be rejected. Thus the estimated model is valid according to this test.

5. Conclusions and Suggestions

This paper is regarded as among innovative studies in terms of using such methods as mathematical modeling and econometrics models in accounting and financial sciences area. It is regarded innovative because similar studies have rarely used mathematical modeling and econometrics simultaneously. Thus reliability of the research results has increased remarkably. Besides companies of the statistical universe, the results of this paper are applicable to all economic firms that wish to assess and determine the relation of related financial variables with their performance. In particular, holding companies will enjoy these results highly.

The results of this paper reveal that the relation of variables namely total tax revenue divided by total assets (Rev/A), total tax revenue divided by equity (Rev/E), and total debt divided by total assets (DEBT/A) with efficiency are significant and the rest of variables do not have a significant relationship. So, some suggestions are provided for the researchers.

- Operational Suggestions

With respect to the results, suggestions are provided briefly.

- Investment companies may increase total tax revenue and efficiency by proper allocation of the assets to the profitable areas.

- Investment companies must have a particular attention to debt instruments when financing and increase their low-profit loans.
- Investment companies can increase efficiency by decreasing equity.

Table 6- The results of Ramsey Test

Table 6 The Results of Ramsey Test

F-statistic	0.336525	Prob. F(1,8)	0.1778	
Log likelihood ratio	0.865304	Prob. Chi-Square(1)	0.03523	
Test Equation: Dependent Variable: SER01 Method: Least Squares Date: 12/0/13 Time: 17:05 Sample: 1370 1390 Included observations: 21				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
SER02	0.001361	0.006763	0.201267	0.8455
SER03	0.001868	0.000917	2.037670	0.0759
SER04	0.012658	0.000769	16.46433	0.0000
SER05	-0.033271	0.024313	-1.368435	0.2084
SER06	0.018761	0.004013	4.674995	0.0016
SER07	-0.032351	0.071750	-0.450886	0.6640
SER08	0.047856	0.029857	1.602857	0.1476
SER09	-0.001394	0.006602	-0.211163	0.8380
SER10	0.002443	0.002614	0.934486	0.3774
SER11	0.008232	0.008303	0.991453	0.3505
SER12	0.007486	0.005177	1.446224	0.1861
C	0.037093	0.014755	2.513872	0.0362
R-squared	0.999690	Mean dependent var		0.3048
Adjusted R-squared	0.999225	S.D. dependent var		0.1199
S.E. of regression	0.003335	Akaike info criterion		-8.2957
Sum squared resid	8.90E-05	Schwarz criterion		-7.6491
Log likelihood	100.1047	Hannan-Quinn criter.		-8.1554
F-statistic	2150.643	Durbin-Watson stat		1.9624
Prob(F-statistic)	0.000000			

- Suggestions for Future Research

Based on the variables of this paper, below suggestions are provided for future studies.

- Engaging such variables as size of company, rate of growth, etc. in the model of relation between credit risk and performance of the investment companies.
- Studying the relation between management risk and performance of the investment companies.
- Studying the relation between liquidity risk and performance of the investment companies.
- Studying the relation between country risk and performance of the investment companies.
- Studying the relation between interest rate risk and performance of the investment companies.
- Studying the relation between exchange rate risk and performance of the investment companies.

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12/11/2013