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EVALUATION OF CREDIT RISK OF LEGAL CLIENTS IN BUSINESS BANKS WITH AN APPROACH TO DATA ENVELOPMENT ANALYSIS (CREDIT RANKING) (CASE STUDY OF REFAH BANK OF FARS PROVINCE)

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ABSTRACT

This thesis aims to determine the factors influencing credit risk credit rating model for corporate customers seeking bank loans being Fars province, using data envelopment analysis is done. This is necessary to evaluate the financial and non-financial information using a simple random sample of n = 136 corporate customers were applying for loans. In this study, 27 variables descriptor includes financial and nonfinancial variables were examined using the variable in the factor analysis and expert judgment (Delphi), 8 were selected variable influencing credit risk DEA model and rewards the performance of companies using it were legal. To validate the model, the regression was estimated at 8 financial and nonfinancial indicators as the independent variable and the performance level of data envelopment analysis model was used as the dependent variable. The results show that 25 companies, the efficiency of the border and has been very effective. The significant difference between the coefficients were determined to test the hypothesis that all indicators except one of the "equity to total assets" have the expected direction and statistically significant at the 95% confidence respectively. Prosperity Bank's corporate credit rating of customers.

Keywords: Credit risk, Credit rating, Clients, Legal, Analytical approach

INTRODUCTION

Banks have an effective role in the economic development through providing financial services. It can be said that banks have a medium role as a catalyst in economic growth. Effective efficiency and performance, banking industry is one of the indexes of financial stability over a time in each country. And the fact that development of banks' credit is associated with the public and banks accelerate the speed of economic growth of a nation and its long-term sustainability with productive activities (Funso, *et al*. 2012).

Banks and financial institutions, as the main symbol of money market, play a crucial role in the fluid flow of cash cycle and credits and subsequent to it, economic development and growth especially in our country. Through the basic role of these firms in the economy, their improper performance can lead to the occurrence of diverse results and irregularity in economic great variables. Return of given resources has always been the thing which has drawn the attention of banks and authorities supervising these institutions (Islami, *et al.* 2011). Today, central banks are interested in the analysis of financial system by taking the systematic risk into consideration. Generally, analysis of financial system can include some risks which might

lead to some significant problems for financial system and ultimately a significant reduction in true gross domestic production. Thus, supervising financial and non-financial risks of the bans is an important section of supervising a financial system (Kozak, *et al.* 2006). Credit performance of the banks is required for increasing investors' ability for exploiting profitable investments. Creation of credit is one of the productive activities of the primary income of the banks (Kargi, 2011).

Today, banks are exposed to the credit risk. Credit risk has been defined as the probability of loosing loans, to some extent or completely, due to credit occurrences (risk of failure). The credit risk determines the internal performance of the bank (Funso, *et al.* 2012). Banks produce credit for growth, maintenance of survival and power of competition in the market, by using deposits for their loaners. In other words, they create income for themselves. Creation of credit is considered as the primary activity of creation of income in the banks. The more the bank is exposed to risk, the more it will tend to have towards experiencing financial crisis and vice versa (Kargi, 2011); although this exposes the banks to credit risk. Any kind of failure in repayment of loans reduces the value of banks' assets and might make the bank face

some difficulties in implementing its commitments. On the other hand, it reduces the rate of profitability as well and therefore, it causes the bank to achieve its own purposes. Process of credit creation puts the banks at the risk of default or lack of repayment which might lead to financial confusion and ultimately bankruptcy. Basel committee defines credit risk as the probability of losing all or a part of the deferred loan (Funso, *et al.* 2012).

One of the problems being currently faced by the banks and it is considered to be the primary concern of the bank managers and requires some thinking for solving it, is the increasing procedure of deferred demands over the recent years. Unfortunately undesirable impacts of this issue including shortage of cash, lack of accessibility of economic firms to cash, slowing of the production cycle and etc. can be clearly seen in the country. The recent condition of the banks indicate that tools which have been used for credit decision makings up to now haven't been efficient enough and in order to improvement of the financial structure of the banks and providing more and more interest for those with a deposit and real applicants of the funds, requires other solutions (Naomi, 2011). The importance of this issue is the reason for which the present research reviews

the ranking of the credit risk of the legal clients demanding loans from the Refah Bank of Fars province by considering the financial and nonfinancial dimensions and by using the data envelopment analysis method.

Credit risk

The credit risk is defined as the probability of the fact that a section of the banks' assets especially their loans are devalued and probably lose all of their values. Since the banks have less equity capital compared to the value of bankruptcy; therefore, management of credit risk is very important and it is the axis of health of a bank and in fact the whole financial system. Since the banks give loans, it is necessary for them to have cautious savings for loan damage in their offices. The more this saving is higher compared to the total loans, the more the risk of the bank will be. An increase in the value of the saving for loan damage in proportion with the total loan is a sign that reception of bank assets becomes more difficult (Greuning and Bratanovic, 2003).

Among these risks, credit risk plays a major role, because up until now, the greatest item of the asset has been loan and usually half or three forth of the total value of all bank assets is assigned to it. The probability of some of the assets of a bank, especially its loans, drops in term of value and maybe become

devalued and identified as credit risk (Rose, 2002).

According to the committee in banking supervision, credit risk can simply be defined as the potential that a borrower or the other party of the bank can't implement their commitments according to terms of the agreement provisions.

Credit risk is the possibility of damage with default assumption of borrowers or the other parties in the market; more generally the credit risk also includes the possibility of damage caused by fluctuations in the value of debt market which is due to the changes in the ability of performance and change of ranking the credit of the borrower. Therefore, theoretically all of the effective factors on the abilities of performance and intention of compliance shall be categorized as the effective factors on the credit risk of the enterprise (Zhang, *et al.* 2013).

Management of credit risk

Basis of a desirable credit risk management can be summarized in identification of the available inherent and basic risks in the processes and activities associated with giving a loan. Methods which are employed for facing the risks usually suggest clear definitions of the policies of risk management in the organization and also the criteria through which credit risk is controlled are specified. Through these methods, the limitations of accepting the risk caused by the adopted policies have been reviewed and adequacy of diversification of the portfolio of the loans is done in the respect of reducing the mentioned risks.

General methods of validating risk management typically include three groups of policies:

The first group of the policies includes limitation or reduction of the credit risk, such as centralizing policies and giving loans to the related dependent organization and institutions.

The second group includes policies of classification of assets, intermittent and continuous evaluations, and capability of reception of portfolios of the loans and other credit tools which makes the credit risks known to the banks.

The third group includes policies of damage reduction by using cautious attempts and cautious savings and giving sufficient authorities to the managers in order to eliminate the damages caused by participation with the clients (Taghavi, *et al.* 2004).

In evaluating the activity of credit risk management, in addition to the loans, other credit domains (inside and outside the balance sheet), shall be taken into

consideration so that it would guarantee that all of the following factors are also considered:

a) Levels of assets and the method of their classification;

b) Levels and integration of stagnant assets;

c) Adequacy of the savings;

d) Management abilities in administrating the affairs and reception of demands;

e) Adequacy and effectiveness of the process of recognition and supervision on the levels of preliminary and moderated risks of the bank and also probable risks with the determined level of accepting credit risks (same, 104);

f) Adequacy and effectiveness of the policies of giving loans and official procedures associated with loan lending and the rate of adherence of the employees and also definition of the levels of decision making authorities in terms of lending loans which leads to guaranteeing the accuracy of adopting decisions in the specified and permitted areas;

g) Banks shall have some processes in the respect of management of reception of the lent loans and their profit and also other related costs instead of the determined period of time and terms of repayment of installments;

h) Establishment of mechanisms for determining and limiting stagnant loans;

i) Establishment of mechanisms for supporting the rights of creditors in terms of damaging loans;

j) The reporting system of the bank shall prepare some accurate and complete temporal reports of the rate of the credit risk by the banks;

k) Preparation of up to date information about the loan borrowers through establishment of the system of credits information (Taghavi, *et al.* 2004).

Evaluation models of credit risk

Financial institutions can divide the clients into various groups according to the available information; but the effective tools shall be developed which helps in doing these classifications. Techniques of mechanical learning and artificial intelligence are new and improved methods which can help develop these tools. Their integration can be useful in minimizing the weaknesses of various techniques and therefore development of the models which can be more accurate than normal statistical techniques (Danenas and Garsva, 2012).

Up until now, several models have been used for application in the process of credit scoring. The following items can be referred to among these models:

- Discrimination Analysis
- Linear Probability Models, Logit Model and Probit Model
- Models based on Options Pricing Theory Model
- Artificial Neural Network Model (Taghavi, *et al.* 2007).

Most preliminary researches are distinguished based on analysis. Those with most applications and the most developed ones have been developed in 1968 by Altman, *et al.* Altman obtained two different samples with 96 and 79% accuracies. Reliability of its prediction has been shown over two years (same, 1945).

Zmijewski (1984) used the principles of maxim probability and two-variable probits and simple probability for a series including 40 bankrupted enterprises and 800 non-bankrupted enterprises and a prediction sample including 41 bankrupted enterprises and 800 bankrupted enterprises which have been gathered from the stock exchange of New York and America and obtained a 27% accuracy for the total series of the related data (same, 1946).

Springate (1974) developed their model by using a stepwise multiple discrimination analysis to select 4 proportion which describes a enterprise going through bankruptcy the best possible way. He

obtained a 92.5% rate of accuracy by using 40 experimented enterprises through Springate. After testing it in comparison with the other samples, he obtained a 83.3% and 88% rates of accuracy.

Ohlson (1980) used a logit approach for structuring the credit risk model and obtained 96.12%, 96.12% and 92.84% accuracies respectively for prediction over a year, two years and one or two years. Some results have shown that neural networks and other classification techniques of mechanical learning are comparable (Ohlson, 1980).

Danenas and Garsva (2009), in their researches, have shown that application of genetic algorithms and also techniques based on group intelligences and ant colony optimization and particle swarm optimization for formation of hybrid methods can lead to better results from what is obtained manually from support vector mechanism (SVM) for selection parameters (Danenas and Garsva, 2009).

Researchers use the method based on support vector mechanism (SVM) for the issues associated with credit risk of choosing the parameter based on GA. These researchers report the advantage of GA optimization technique and state that group intelligence has also been used for optimization of classifiers based on support vector

mechanism (SVM) (Danenas and Garsva, 2012, 1946).

Zhou, *et al* (2008) recommended a new hybrid ant colony optimization (ACO) and approximate series approach for classification of clients (Zhou, *et al.* 2008, 1).

Xuchuan (2008) used particle swarm optimization for selecting an efficient parameter and they tested this method for scoring the personal credit. Another common approach to model optimization is based on support vector mechanism (SVM) of phase logic and phase integral (Xuchuan, 2008); whereas several samples of these techniques can be found in many articles, they suggested multiple components of hybrid techniques for evaluating credit risk. Hao, *et al.* (2007) used an ambiguous instead of a phase series; whereas Hwang, *et al.* recommended the support vector mechanism (SVM) with phase minimum squares and phase super pages (Hao, *et al.* 2007).

Min, *et al.* (2009) recommended a combination of analysis of main components which have made the reduction of the number of dimensions and elimination of autocorrelation of the space of the preliminary samples and therefore improves the accuracy of classification. Discrimination analysis integration approach has also been recommended as a evaluation technique along

with a classification technique (Min, *et al.* 2009).

Merkevicius, *et al.* (2007) used a discrimination analysis along with self-organization plans to present a SOM-Altman hybrid model for predicting bankruptcy, so that they would find optimal weights for proportions of the Altman model. A model has also been recommended for predicting the changes which include these two techniques along with a supervised neural network which is used for increasing the performance in terms of accuracy. Danenas and Garsva have also used support vector mechanism (SVM) combined with discrimination analysis for evaluating credit risk (Danenas and Garsva, 2012).

In order for the credit scoring models to have sufficient accuracy and credit, the following items must be considered:

- Sufficient information and data shall have been gathered of good and bad loans.

- Regularly updating data and information in order to make sure of application of changes in the model coefficients and relations between variables and effective factors on loan performance.

- Making sure of the fact that a new group of clients under credit scoring are similar to the previous groups whose credit

scoring has been made based on their information.

- A good model shall show accurate predictions in various economic circumstances, thus the information used in the model, shall include periods of stagnation and prosperity.

- Testing the model shall be done with the information and data outside of the model.

- It shall not be expected from a credit scoring model to predict the performance of each client accurately; because the scoring model might put the bad clients in the group of good clients and vise versa. The good model is a model which is able to predict the average performance of the lent loans to a group of clients accurately (Taghavi, *et al.* 2007).

METHODOLOGY

This research is considered to be an applied study in terms of purpose and a descriptive research based on type of research. Also based on the type of research, this research can be considered of a correlative type and in order to gather information, the library method and organizational databases have been used. This research evaluates the credit risk evaluation of legal clients in business banks with data envelopment analysis approach (credit ranking).

The statistical population of this research is the legal credit clients (small and medium enterprises) of the urban branches of Refah Bank of Fars province. With this intention, among 350 legal enterprises demanding loan, by using simple random sampling, 136 legal enterprises borrowing loans from the Refah Bank of Fars province are selected during the years 2010 to 2013 which will be ultimately used for increasing the accuracy and reducing the risk of 146 samples for analysis. Since based on sectional and scale differences, there is the need for a certain degree of congruence between the studied enterprises, in the series of observations, that group of enterprises which have numerical proportions which have been significantly deviated from the means on the same level as them. It is necessary to mentioned that the selected samples, it is better to for the selected samples be chosen from a specific industry and with proper structural sizes. For credit scoring and data analysis, the Altman Z score, the discrimination analysis method, perceptron and neural network and data envelopment analysis have been used.

The recommended methodology of this research includes 5 stages. Three stages of this model start by selecting the studied enterprises and then identification of the basic

indexes affecting the credit risk by using the factor analysis method and experts' judgment for evaluating the performance of legal clients. In the fourth stage, the data envelopment analysis method is used for calculating the credit scores of the enterprises and in the fifth stage, the data envelopment analysis has been validated with the regression model and the outcome obtained from the data envelopment analysis model is analyzed through regression.

RESEARCH FINDINGS

Table 1: determined factors by using factor analysis

Sale	Bank loan	Cash flow	Activity	Profitability	Debt
Current debt to net sale	Rate of received facilities	Current asset	Rotation of constant asset	Rate of assets' return	Constant asst to special value
Short-term loan to net sale	Short-term loan to the whole assets	Good saving to current asset	Rotation of the whole asset	Ratio of profit margin	Current debt to special value
	Short-term loan to current debt	Current ratio			Ratio of total debt to the total assets
		Immediate ratio			Special value to the total assets
		Ratio of current asset			Current debt
					Current debt to the total asset

Table 2: reference series and frequency number of efficient enterprises in making a reference series

DMU	Peer Group	Frequencies
DMU 142	DMU 142	4
DMU 142	DMU 142	22
DMU 144	DMU 48, DMU 72, DMU 131	0

Table 3: rates of improvement of inputs and outputs of the enterprise number 5 for being efficient

DMU	Input 1	Input 2	Input 3	Input 1	Input 2	Input 3	Input 4	Input 5
DMU 5	0.508 to 0.223	1.267 to 0.83	0.735 to 0.481	0 to 1.163	0 to 0	0 to 0	1.175 to 8.66	1.79 to 1.79

Table 4: credit ranking of legal enterprises

Group	Percentage	Credit rank	Definitions
1	12.17%	AAA	This group has the best quality in terms of profit repayment and the original one and it has the least investment risk
2	79.4%	AA$^+$ AA AA$^-$	The second group has a high quality and their difference with the previous group is that the margin of their safety is not as wide as the previous group and its long-term risk is lightly more. It has a weaker perspective from top to bottom within the group.
3	84.6%	A$^+$ A A$^-$	This group has a desirable condition. In terms of primary and secondary repayment has a proper condition, but it is possible for them to face problems due to occurrence of some incidents. From top to bottom, the conditions become worse within the group.

4		BBB$^+$ BBB BBB$^-$	This group is considered to be of average degree and it seems sufficient in terms of primary and secondary repayment, but in the long-term it faces some problems. From top to bottom, the conditions become more undesirable within the group.
5	10.4%	BB$^+$ BB BB$^-$	The risk of this group is high and in terms of primary and secondary repayment, it doesn't have a good guarantee either now or in the future and in fact it kind of lacks confidence.
6	21.8%	B$^+$ B B$^-$	This group doesn't have a desirable condition in terms of primary and secondary repayment and it lacks the specifications of a desirable investment.
7	58.9%	CCC CC C	It is either in the pending mode or its primary and secondary repayment, it has many risks and it is often in deferred cases and in the bankruptcy mode.
8	52.44%	DDD DD D	This group is in the worst conditions in terms of primary and secondary repayment of loan.

6.2. Testing the hypotheses

In this research, 5 hypotheses are mentioned. In order to test the research hypotheses, the significance of the coefficients shall be reviewed. A test which is used in the regression model with this intention, the β significance test and in regression, logistic is the productive test and its value is reviewed in the 95% confidence distance in order to reject and accept the H_0 hypothesis, as follows:

$H_{O:}$ β=O

$H_{1:}$ β≠O

The H_0 hypothesis is only accepted when the probability of β significance error is more than α=0.05 (if it is at the area of acceptance of H_0); by considering these explanations, confirmation or rejection of the mentioned hypotheses are reviewed in this research:

There is a relationship between financial and nonfinancial indexes and credit risk.

Given the obtained coefficients, in *W* significance test and β statistic, all of the indexes are significant except all indexes and there is a significant relationship between financial and non-financial indexes and credit risk.

Data envelopment analysis, as one of the nonparametric statistical methods, has the required efficiency for credit ranking and credit risk estimation.

In this research, in order to validate of the ranks obtained from the data envelopment analysis method, the linear multivariate regression model was used so that the accurate estimation power of the efficiency ranks would be proved.

Determination coefficient is equal to 0.75 in the regression method which means high explanation power of the regression model. In other words, the input variables of the regression equations haven't been able to

express about 76% of the variance of the changes related to the dependent variable. Therefore, the calculated ranks, there is a significant difference with the ranks obtained from the regression model by using data envelopment analysis and the second hypothesis of the research which is indicative of the efficiency of the data envelopment analysis method for estimating the credit rank, is accepted.

The neural network model, as one of the parametric statistical methods, has the required efficiency for estimating credit risk and credit ranking of clients.

Due to predicting the rates of credit risk through this model, the possibility of estimation of model efficiency was made possible by using a comparison between the predicted and real results. Therefore, the neural network, with an error equal to 0.05%, was able to estimate the efficiency of the observations in compliance with the truth equal to 95.94% and this is indicative of the high ability of the neural network in predicting the credit risk of the clients and the third hypothesis of the research, being indicative of the efficiency of the neural network model, is accepted in predicting the credit risk of the bank clients.

Logistic regression, as one of the most applicable parametric statistical methods, has

the required efficiency for estimating the credit risk and credit ranking of the clients.

The obtained results show that if this model was used, about 87% (with a 0.5 threshold) of the facilities was can be assigned to the true clients and the fitted model is able to estimate the credit risk; therefore the fourth hypothesis of the research is also confirmed.

The neural network model, in comparison with the two data envelopment analysis and logistic regression models, is more efficient.

By comparing the true results and the predicted data through the neural network model, the high predicting power of this model (94.95% efficiency) is confirmed in comparison with the other two models of the fifth hypotheses.

DISCUSSION AND CONCLUSION

Giving credit loans to clients is considered to be one of the most important responsibilities of the banks. After collecting financial sources, the banks in each country assign these sources to different economic sections. In fact, this attempt of the banks reinforces different economic sections in each country in doing their responsibilities better and ultimately, it provides the necessary field for the country's economic growth and development. If the banks assign the financial sources accurately to their qualified clients,

they can achieve this important matter. Accurate assignment of the financial sources, in addition to achieving the above purpose, it will provide the required conditions for the banks to continue to survive. In this case, in this attempt, the crucial point is to recognize their risky conditions accurately before giving loans to qualified clients, so that the efficiency of the adopted decisions is promoted. It is obvious that any kind of attempt in the field of controlling after giving loans will have little advantage. Given the above points, at the end of this article, it was attempted to design a credit risk management model for this intention by using the data envelopment analysis method. Generally, the results obtained from this research can be summarized as follows given the main issue of the research:

1- Existence of the statistical significant relationship of the effective financial and nonfinancial variables on credit risk of the legal clients of Refah Bank of Fars province is confirmed. Also the significance and sign of dependent coefficients of the model are indicative of the confirmation of economic and financial theories in the field of determining factors of the credit risk.

2- According to the obtained regression coefficient, variables of current asset to

constant asset, rate of assets' return, achieved permit and repayment record have a direct relationship with efficiency and a diverse relationship with credit risk and credit rank. Therefore, greatness of the mentioned indexes is considered to be desirable.

3- Indexes of short-term indexes to the total assets, short-term loan to net sale and the total assets based on the obtained coefficient have a diverse relationship with the rate of efficiency and a direct relationship with credit risk and credit rank and it is obvious that the fact that these indexes are less is desirable.

4- Among the variables used in this model, the index of short-term loan to net sale has the highest regression coefficient and the most impact on credit risk and index of current asset to constant asset has had the least rate of impact on credit risk. In this research, in order to validate of the ranks obtained from data envelopment analysis method, a linear multivariate regression model was used so that the power of accurate estimation of the efficiency ranks would be proved; the determination coefficient is equal to 75.5% in regression model which is indicative of the high explanation power of the regression model. In other words, the input variables

of the regression model have been able to express about 76% of the variance of the changes related to the dependent variable. Therefore, the calculated ranks doesn't have a significant difference with the ranks obtained from the regression model by using the data envelopment analysis and the third hypothesis of the research is accepted which is indicative of the efficiency of data envelopment analysis method for estimating the credit rank.

5- Among advantages of data envelopment analysis model in comparison with other evaluation models of credit risk, we can refer to capability of this model in providing some solutions for exploiting the enterprises demanding loan. Under the data envelopment analysis approach, both ranking of the legal clients of the bank can be reviewed and also by identifying the reference firms for each of the inefficient firms help them reach the border of efficiency. In fact, this model is able to help the ranked enterprises in the respect of being more exploitation by presenting proper and useful solutions.

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