CHAPTER TWO

RESEARCH METHODOLOGY
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2.1. Introduction

As usual, the research methodology plays vital role in testing several matters and use the same in arriving at appropriate results. Generally, it causes that to be reasonable researches. The methodology of research can properly refer to the theoretical analysis of the methods and the relevant framework allocated to a field of study.

In recent years, by improving technology and computer applications, the research methodology has been increasingly used as a pretentious substitute for the method in scientific and technical contexts.

2.2. Selection of the topic

Nowadays, due to liberalization of global trade, instability of foreign exchange income from oil exports, recent recession in global markets, the tendency of non-oil export development, has doubled in volume and extent. In Iran in earlier decades in order to allocate fairly sufficient foreign exchange revenues caused by oil export, non-oil support export received no more attention. In this regard, recent statistics has confirmed that during boom years of foreign exchange incomes, attention to non-oil support policies
was more. While applying the proper policies to support export have caused the increase of foreign exchange incomes and economic independence from oil revenues and reduction of economic crisis in other countries enjoy more stability. In this respect, some export facilitations such banks, are one of the most important factors in export development area for each country.

Providing necessary financial revenue and facilities and guarantees are the necessities of export affairs in which these banks do such an important task and especially in recent worldwide financial crisis their importance has doubled. For example, in the recent worldwide crisis economic based on oil revenues due to the liquidity reduced too much and need of financing and reconsideration of financing methods was very vital. The way which is an easy choice on liquidity ascendance may not be a viable method economically.

In such a situation, lack of an accurate and appropriate financing infrastructure is an obstacle of trade. Limited access to financing resources and high costs, lack of insurances or guarantees, have deterrent effects on trade and export potentially, especially small and medium companies (SMEs). Therefore, the supporting and facilitating institutions in order to facilitate foreign trade are too necessary.
Now the government relying on the bank’s attempts to increase banking credit lines provided by the banks aimed to export development.

Therefore, In Iran, the importance of non-oil export to attain emancipation from single – product economy caused that Export Development Bank of Iran’s (EDBI) statute was approved by bank’s general assembly in 28 articles and 10 clauses in 1991. The initial capital was approved with initial capital of fifty billion rial to promote export development and expanding commercial and economic communication with other countries. Its activities formally began in 1991.

EDBI is the only specialized Export Development Bank of Iran (EDBI) which offers export credit services and other financial services to support the international activities of Iran’s companies.

According to definitions of EXIM banks and goals and mission of EDBI which are already mentioned before in details, credit services is its main activity in order to provide a major portion of bank’s assets. Moreover, the huge portion of earning and profit of the bank is allocated from the short term, medium term and long term credit facilities. Obviously, in such a situation, instituting a credit evaluation system and using the result to improve future performance and to take balance between risks and profits is necessary. On account of the lacke of such a system,
forming an efficient credit portfolio to optimize the bank’s benefits is impossible.

In this regard, one of the most important and serious problems of banks and financial institutions in recent years are related to the factors such as: poor standards of credit allocation to borrowers and other parties, poor risk management portfolio, and less attention to economic changes. Some such circumstances can deteriorate the situation of bank’s performance. According to previous studies, 60% of bankruptcy in recent years occurred due to customer’s credit risk. Other activities such as banking transaction, trade finance, and foreign exchange transaction are common functions in banks but, for majority of the banks loans are the largest and most obvious source of credit risk and bankruptcy as credit risk’s exposures have still remained as the main problem of reputable international banks. The recent crisis of 2008 has confirmed this claim.

Credit risk, in short, based on Ball Committee’s definition is the possibility of failure of borrower or other contract partners to perform their obligations against the bank according to the agreed conditions. Also, quoting from Ball Committee “the efficient credit risk management is an essential condition for long-term success of each bank. Thus, today diagnosis, measurement, surveillance and control of credit risks are among the most controversial issues raised in the field of monetary and banking
system of each country. Moreover, in the countries like Iran, due to lack of credit rating by valid international ranking institutions such as: Moody’s, Fitch and S&P, the importance of the subject has multiplied significantly.

2.3. Significance of the Present Study

Improvement of export sector is one of the main factors affecting national income and causing sustainable economic growth, reduction of unemployment and obtainment of social justice. It is among the parameters emphasized by economic policymakers of all countries. The export sector plays a crucial role in balancing payment balance and increasing reserves. Currently in Iran, one of the main concerns of legislators and policymaking institutions is the development of economically active partners in international markets. Efficiency of policies and promotion strategy in facilitating exportation and improvement of non-oil exports is largely dependent on the policies related to monetary and banking supervising authorities. Enforcement of such policies depends on the bank services provided by the banking system. In fact, banking system plays a dual role in policy making on one hand and bank services provision for export facilitation on the other hand.
It is already mentioned that one of the centers established with the aim to provide finance facilities in the export sector during the years of the First Economic, Social and Cultural Development Plan of Islamic Republic of Iran was Export Development Bank of Iran (EDBI) in 1991.

Generally speaking, EDBI is the only specialized bank active in export sector, supporting exporters to increase their non-oil experts and obtain incomes in foreign currencies. Continuation of this strategy due to its positive results will lead to achievement of macroeconomic objectives. Presently, regarding the special role of this bank in non-oil experts, more than 50% of the distinguished exporters of Iran are among the clients of this bank.

On the other hand, lack of an efficient evaluation system reduces the productivity and increases risk probability of organization and institutions active in the system, rendering them unsuccessful in achieving their targets. Thus, nowadays, the organizations, using effective applied-scientific methods, can balance between their institutional inputs and outputs and with continuous evaluation of their performances and risks, can institutionalize productivity. It is evident that achieving these objectives and meeting the said requirements and the objectives of this plan can only be done by measuring activities using a quantitative model and designing and initiating a performance evaluation system.
Moreover, all monetary and financial institutions naturally encounter different types of risks which, if not identified and controlled, will cause irrecoverable losses. Therefore, one of the important elements in analyzing the performance of such institutions is risk evaluation including credit risk evaluation. It enjoys such importance that international supervisory institutions hold credit risk management system as a must for all the banks and consider the system one of the most important supervision indices in analyzing banks performance.

Accordingly, in order to decrease credit risk, the banks are to analyze the credit status of clients before granting credits. The analysis includes credit status of the client, client’s ability to settle dues and estimation of the probability of failure to fulfill obligations in the future. The analysis and its results are important for the bank from different aspects. The determination of credit risk evaluation helps banks in determining the required reserves for facilities, i.e. calculation of bank capital sufficiency.

The increase of candid ants, client dishonor for future periods, limitation of time and manpower at credit departments, management of affairs and making decisions on credit appropriation are only possible through designing credit risk models on the basis of a clients ranking system. A good ranking system should be able to predict the possibility of a given client’s failure to settle debts with acceptable precision.
Balancing supply and demand in bank resources and facilities, optimal management, decrease of delayed dues and removing pawn-based system are among the factors highlighting the necessity of implementation of a ranking and validating system in the banking system.

On the other hand, in Iran, heterogeneous information, low information reliability, numerous information centers, numerous information producers and lack of control requirements are among the reasons making establishment of a comprehensive database in banking system through a ranking system necessary.

Presently, there are various models and methods for validating clients, each based on a specific pattern. The existing models used by international accreditation and ranking authorities are based on modern global economic conditions and the world business environment.

Since credit ranking models are designed and developed on the basis of experimental-historical data, it can be claimed that credit ranking is an objective tool for risk evaluation.

2.4. Objectives of the Study

The present research attempts to attain the following objectives:

1. To study the background of EDBI.
2. To examine the performance or efficiency of EDBI in the study period (1997-2007).

3. To study the role of EDBI in Iran’s economic development.

4. To find out problems result of credit risk and effect factors on EDBI’s borrowers credit risk.

5. To suggest a strategy and statistical model for performance of EDBI’S borrowers credit scoring.

2.5. Hypotheses of the Study

In order to fulfill the above objectives the following hypotheses are formulated for testing.

1. EDBI’s bank has shown good performance and progress since establishment. In addition to this, efficiency of EDBI increased in the period of study.

2. The government plays significant role in the progress of EDBI. The capital of EDBI financed by government has a significant effect on efficiency of EDBI.

3. Loan's granted for non-oil exports are effective but the share of EDBI is less in non-oil exports. On the other hand, performance efficiency of EDBI has a significant effect on the non-oil exports but the share of it isn’t high.
4. The ratio of default loan (probability of impairment loans group) is high. In addition to this, by using credit scoring model it is noticed that the share of default loan in bank portfolio is high.

2.6. Scope of the Study

EDBI and other financial systems have been investing vast amount money worldwide, the world is still struggling with crisis, loss and bankruptcy.

For this reason we want to study and suggest a beneficiary model to select and distinguish between good and bad borrowers or a bank. It will be beneficial to decrease the ratio of default loan. The bank could decide, in a better way, to provide loan on export area. It will be useful to bank in its future development decisions.

This research will be beneficial to government, to take decisions about financing the bank. For those who will pursue their research on similar topic, for those students/researchers, it will be useful.

2.7. Research Methodology

The present research in course of action is a descriptive, post event research. In view of data gathering it is documentary. It is descriptive since it explains all aspects of a situation and
conditions which are related to the functioning of efficiency and credit scoring. This research is target oriented: it is applicable as a study. The related results are useful for bank management and staff even for other state or non-state organizations; it is useful to recognize effective factors of credit scoring due to the pertinent problem of impairment (default) loans.

2.7.1. Primary data

The statistical universe of the present research study is divided in two parts:

In part one: in order to evaluate the performance of EDBI, the statistical universe has included all branches of related bank in Iran.

The Bank network is comprised of 34 local branches (5 branches in Tehran and 29 branches in main provinces) and one Representative Office in Kazakhstan along with a wholly owned bank in Caracas, Venezuela and a subsidiary partially owned bank in Minsk, Belarus.

The study is restricted to EDBI’s branches in Iran that were established before 2007 only.
Table 2.1 *Branches of EDBI*

<table>
<thead>
<tr>
<th>S/No</th>
<th>Name of branches of EDBI</th>
<th>State in Iran</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Central branch</td>
<td>Tehran</td>
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<tr>
<td>2</td>
<td>Tajrish</td>
<td>Tehran</td>
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<td>3</td>
<td>Mirdamad</td>
<td>Tehran</td>
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<td>4</td>
<td>Keshavarz blvd</td>
<td>Tehran</td>
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<td>5</td>
<td>Pamenar</td>
<td>Tehran</td>
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<td>6</td>
<td>Ahvaz</td>
<td>Khoosestan</td>
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<td>7</td>
<td>Astara</td>
<td>Ardabil</td>
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<td>8</td>
<td>Arak</td>
<td>Markazi</td>
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<td>9</td>
<td>Boushehr</td>
<td>Boushehr</td>
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<tr>
<td>10</td>
<td>Qom</td>
<td>Markazi</td>
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<td>11</td>
<td>Hamedan</td>
<td>Hamedan</td>
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<td>12</td>
<td>Esfahan</td>
<td>Esfahan</td>
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<td>13</td>
<td>Gorgan</td>
<td>Golestan</td>
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<td>14</td>
<td>Kerman</td>
<td>Kerman</td>
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<tr>
<td>15</td>
<td>Kermanshah</td>
<td>Kermanshah</td>
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<tr>
<td>16</td>
<td>Khorramabad</td>
<td>Lorestan</td>
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<td>17</td>
<td>Mashhad Khayam blv</td>
<td>Khorasan</td>
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<td>18</td>
<td>Oromyeh</td>
<td>West azarbayjan</td>
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<td>19</td>
<td>Rasht</td>
<td>Gilan</td>
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<td>20</td>
<td>Sari</td>
<td>Mazandaran</td>
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<td>21</td>
<td>Shiraz</td>
<td>Fars</td>
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<td>22</td>
<td>Tabriz</td>
<td>East azarbayjan</td>
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<td>23</td>
<td>Yazd</td>
<td>Yazd</td>
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<td>24</td>
<td>Zanjan</td>
<td>Zanjan</td>
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<td>25</td>
<td>Chabahar</td>
<td>Sistan balochestan</td>
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<td>26</td>
<td>Gheshm</td>
<td>Hormozgan</td>
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<tr>
<td>27</td>
<td>Kish</td>
<td>Hormozgan</td>
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In part 2: In order to evaluate credit risk, all legal borrowers of related bank branches that have received the facilities in 2007 are defined as the statistical universe in this case. The reason of choosing legal firms is their available reliable and audited financial data. For scoring one financial year is selected. Before this period isn’t available the financial statement authority from EDBI’s customers.

2.7.2. Secondary Data

The secondary data will be collected from various books, thesis, journals, articles, and newspapers and published literature. Material will be collected from the bureau of economics and banking and risk management and statistics. The research papers, government reports, annual reports of EDBI and annual reports of legal customers will be used as secondary data.

2.7.3. Statistical Sample and Method of Sampling: (N)

Similar to primary data, the statistical samples in this research are also divided in two parts:

In the first part, those branches will be selected as statistical samples in which credit activities were started prior before the end of financial year 2007 and should have continued the activities
until now. So, from among the 33 active branches, twenty seven (27) were selected as the samples. We have used panel data to evaluate efficiency model for the bank (three years 6 monthly for 27 branches).

The required samples of second part included the legal customers whose audited financial statements in the year 2007 were available. In this type of models, we should use cross sectional data to credit scoring. Therefore financial year 2007-2008 was selected as studied term to evaluate credit scoring model. Besides, we had encountered limitation of audited financial statement for customer before financial year 2007-2008.

2.7.4. Methods of Data Analysis and Testing hypotheses

In order to evaluate the EDBI’s performance, the parametric (regression) methods will be used. So, at first, EDBI’s efficiency proceeding during the period of three years, 6 monthly performances and the relation of input and output variables will be estimated by using OLS method regression (Ordinary least method of phase logic).

In order to evaluate the role of bank in non-oil export OLS method regression were used also.

In order to evaluate a credit scoring model of EDBI’s borrower’s multivariate regression model (logit) model were used.
2.7.5. Chapter Scheme

The research study is divided into six chapters.

First chapter – Introduction

This chapter highlights the historical background of EDBI and constitution of the bank, along with the aims, objectives, rules and functions of EDBI.

Second chapter- Research Methodology

It deals with the need, importance, objectives, hypothesis, and scope and research methodology of the study and the review of related literature.

Third chapter- EDBI’s Performance

This chapter covers the progress of EDBI, its total deposits, loans granted to the customers, assets, capital, financial indexes and its turnover, besides, EDBI has compared with Iran banking market and other EXIM bank in the world.

Forth chapter- EDBI’s Efficiency Model

In this chapter the data collected from EDBI’s branch via stochastic frontier model to evaluate the efficiency of the bank, will be analyzed.

Fifth chapter- EDBI’s Borrowers Credit Scoring Model

This chapter covers definition of statistical and no statistical models that are used for credit scoring. Then it has
suggested a logit model to credit scoring of EDBI’s customers. Finally, the model presents the quantitative factors affecting on default loan.

**Six chapter- Conclusion and Recommendations**

The remedies and solutions, for the improvement of EDBI would be suggested in this chapter, on the basis of conclusions.

**2.7.6. Limitations of study**

The study is restricted to Export Development Bank of Iran (EDBI) only. While doing this research, only legal customers from each branch would be selected in the year 2007. While collecting the information from the customers there may be difficulties in getting required information. The available data of EDBI is in rial currency, which is to be converted to US$ and rupees. There may be difficulty in conversion of currency. These limitations of study will have their impact on the conclusion of the study.
2.8. Review of Literature

2.8.1. Review of Literature on Efficiency Model

Bank efficiency studies are fairly abundant by now. But only a few apply two or more techniques to an identical data set, especially European data (Weill, 2004). Studies that compare parametric and non-parametric techniques are Ferrier and Lovell (1990), Sheldon (1994), Resti (1997), Bauer et al. (1998), Casu and Girardone (2002), Weill (2004) and Beccalli et al. (2006).


7. same reference

Farrell (1957)\textsuperscript{9} suggests a non-parametric approach to measure technical efficiency by a linear programming method designated as data envelopment analysis (DEA). Though widely used, DEA suffers numerous shortcomings such as sensitivity to random deviations, outliers, and data errors. It also requires large datasets. Aigner et al. (1977)\textsuperscript{10}, and Meeusen and Broek (1977)\textsuperscript{11} propose a parametric approach to measure technical efficiency: stochastic frontier analysis (SFA). Both methods are intensively used in the analysis of the efficiency of banks and financial institutions. In the review by Berger and Humphrey (1997)\textsuperscript{12}, approximately half of 130 studies used a parametric approach.

Berger and Mester (1997)\textsuperscript{13} discuss various SFA models and come to the conclusion that the models (in terms of cost efficiency and profit efficiency) give approximately the same estimates of technical efficiency of US banks using data for 1990-1995.


Bauer et al. (1998)\textsuperscript{14} compares variants of different approaches (DEA, SFA, as well as the distribution free approach, DFA, and the thick frontier approach, TFA) to measure the efficiency of US banks over the period 1977-1988. They conclude that, given the same set of four inputs and four outputs, parametric and nonparametric methods are not mutually consistent. Most papers dealing with the technical efficiency of banks study just one country. Among the first papers comparing the technical efficiency of banks in different countries was the study of Maudos et al. (2002)\textsuperscript{15}, who consider the cost efficiency and profit efficiency of banks in ten leading EU countries during 1993-1996. The sample included 3,328 observations of 832 banks. The authors conclude that the estimated cost efficiency is lower than the estimated profit efficiency and that the correlation between the two estimates is low. Mid-sized banks and banks with a high ratio of loans to assets are found to be most efficient. Market concentration positively correlates with profit efficiency and negatively with cost efficiency.


Casu and Girardone (2002) evaluate the cost characteristics, profit efficiency and productivity change of Italian financial conglomerates during the 1990s using SFA, DFA and DEA. Beccalli et al. (2006) measure cost efficiency of stock-market listed European banks in 1999 and 2000. They investigate the link between efficiency measures and the market performance of financial institutions by means of SFA and DEA and find that percentage changes in stock prices reflect percentage changes in cost efficiency, particularly those derived from DEA. Furthermore, SFA efficiency scores are slightly higher than DEA scores, namely 85% versus 83% and DEA efficiency scores are more dispersed compared to SFA.

The following papers present an analysis of banks in developing countries.

Banks are most efficient and government-owned banks least efficient. Furthermore, early-privatized banks are more efficient than later privatized banks (a result not explained by a selection effect).

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Carvallo and Kasman (2005) estimate a common cost frontier with country-specific environmental variables for a panel of 481 banks from 16 Latin American countries. Their results suggest a wide range of inefficiency levels across countries. Underperforming banks tend to be small, undercapitalized, and more prone to engage in risky financial policies.

Lensink et al. (2008) use stochastic frontier analysis for a sample of 2,095 commercial banks in 105 countries during 1998-2003. Unlike most studies, they find that foreign ownership negatively affects bank efficiency. The authors use, as we do here, the SFA specification suggested by Battese and Coelli (1995). As in most of the papers mentioned above, they also use the BankScope database and give the standard caveats about its data imperfections (see e.g. Bonin et al., 2005b). Among the more notable BankScope database drawbacks are its inclusion of non-bank financial institutions, repeated use of several banks in the data, and failure to compensate for the different accounting


21. same reference
systems used by banks in different countries all problems that are particularly acute in transition economies.

A handful of papers tackle the technical efficiency of Russian banks.

In addition to Fries and Taci (2005)22, this problem is discussed in the following. Caner and Kontorovich (2004)23, the pioneers in estimating the technical efficiency of Russian banks, use data for 1999-2003. They conclude that the efficiency of Russian banks is significantly lower than the efficiency of European banks. Styrin (2005)24, analyzing data for the period 1999-2002, finds an increase in the average efficiency of Russian banks. He includes the ratio of past due loans to total loans as a proxy for the riskiness of bank financial policies. The focus of the paper is to determine the factors that influence efficiency. He finds that different methods produce different results, but a negative correlation between efficiency and ratio of past due loans to total loans is common to all methods.

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Balash and Pavlyuk (2005)\textsuperscript{25} use data for 2000-2003 for 160 Russian banks. Applying a profit-efficiency SFA approach, they conclude that Moscow banks are less efficient than regional banks and that large bank are most efficient.

Golovan (2006)\textsuperscript{26} determines the factors that are important for the efficiency of Russian banks in issuing loans and attracting deposits. He finds that the average bank efficiency increased over 2003-2005. The most efficient lenders are Moscow banks and banks with a high capitalization. A high ratio of past due loans is negatively related to efficiency. The larger the bank, the greater its efficiency. As we might expect, this relation is weaker for large banks, since large banks diversify their activities and their efficiency in issuing loans may be lower than that of specialized mid-sized banks.

Mohamadi and Hosseini Zadeh (2008)\textsuperscript{27} in an essay entitled “the application of the AHP/DEA approach in classification of insurance branches” studied the ossification of Iran insurance

\begin{enumerate}
\item \textsuperscript{26} Golovan, S.V. (2006). Factors which influence the efficiency of Russian banks. Applied econometrics (Prikладная економетрика), 2, 3-17 (in Russian).
\item \textsuperscript{27} Mohammadi, Ali, Hossein-Zadeh, Somayeh, consolidated approach to application of AHP / DEA ranking of insurance agents, Journal of Economic Journal, Fall 1386, No. 26 consecutive.
\end{enumerate}
branches by the use of a combined qualitative and quantitative approach. In this method, firstly, a data enveloped analysis model for every pair of branches is involved without regard to other branches. Then by the use of obtained results, the complete classification is carried out by forming pair comparison matrix from solving data enveloped analysis models and by solving the hierarchy process model. The pair comparison matrix is based on solving the data enveloped analysis model for every pair of branches, but the final classification is carried out by the use of a qualitative approach. According to the findings, the merit of the suggested model is to classify all under studied branches because in data enveloped method, more than one branch obtained one as the efficiency score in which their classification will be difficult. Therefore, making use of such combined approach is for solving such problems.

**Eslami Bidgoli and Kashani Pour (2005)**28 in an article entitled “The comparison and evaluation of efficiency measurement methods of bank branches and presenting a proper method” studied the two problems. Firstly, they measured the efficiency of 142 Tejart Bank branches by the use of three – lateral methods (data envelope analysis, the accidental frontier method and the financial relations) and in the second phase, they introduced the

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data enveloped analysis model by analyzing and interpreting the results for measuring the efficiency of bank branches.

Razmi and Bamdad (2007)\(^{29}\) in an essay entitled “The application of PCA method in evaluation of providers” have presented a model in order to evaluate providers by the use of PCA method. This model classified providers according to the indexes of the model. Then they referred to the conducted case studies and stated that the finding of this model is in accordance with reality.

Azadeh and et al (2009)\(^{30}\) in an essay entitled “The combination of parametric models and non-parametric models for classification and grading the electricity power distribution companies” presented a model and a comprehensible method for evaluating the performance and grading the power companies. In the suggested approach of this research, the DEA model is obtained as a non-parametric model and the corrected ordinary least squires and a parametric model by the principal component analysis combines with the research model in order to record the accurate grindings. In this method, firstly, the efficiency rates of Iran electricity power distribution companies are extracted by the use

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29 - J. razmi Sh. bamdad, PCA method used in evaluating suppliers, the second national conference logistics and supply chain, in 2007

30 - Azadeh, MA, M. Sadiq Nick amal, omrani Hashem, the combination of parametric models to rank electricity distribution companies, Journal of Industrial Engineering and related topics, in the nineteenth, No. 1, 2009
of data enveloped analysis models (DEA) and corrected ordinary least square (COLS) and then, the results of these two models are used as the input indexes in the PCA method. In this research, 38 power companies are graded by the use of the presented model and approach and later on studied the validity and reliability of the findings.

**Azadeh and Siavash (2002)** in an essay entitled “The determining the Economic importance of different industries by the use of multiple analysis methods” graded the sub-branches of industry for the first time in the world by the use of multiple analysis method and reflected the strong and weak points of the sub-branches. Accordingly, they classified the country industries based on the type of activity and by the typical international standards by the use of economic indexes. The classification criterion was based on the international standard classification of economic activities (I.S.I.C.) presented by Unido organization. Industry is divided based on two to four digit codes in this standard. The two digits show the major subbranches of industry. They made use of major principal component analysis (PCA) and DEA method in order to compare the subbranches. The findings show the importance of each one of applied indexes and signify

1. Azadeh, Mohammad Ali and Jalal Siavash, determine the economic importance of different industries, using multiple analysis methods, paper (Volume: 3, No: 73), 2002.
the strong and weak points of each one of subbranches of industry in relation with the under studied economic indexes.

Makuee, Sajadi and Pashin (2009) in an essay entitled “The relative evaluation of similar companies regarding the financial criteria’s by DEA method (case study of automobile spare parts companies)” suggested the DEA non-parametric method in order to evaluate and grade the performance or companies with similar activities based on the financial indexes. The 29 automobile spare parts companies in 2002 – 2004 are studied in order to use this model experimentally. The results of this method are compared by the use of a DEA method without input which acts by some financial relations as output. The results of this group research show that: firstly, these two models can be applied and the simple analysis method complements. Secondly, there is a relative relation among the efficiency of company and the operational profit rate and properties productivities. In addition, between the size of company and the efficiency rate, there is a positive relation.

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32- Makuee, Ahmad, Sajadi, syyed jafar and Pashin pegah, evaluation relative to similar companies according to financial criteria using DEA (case study companies, car parts maker), Economic Journal, 29 Serial, Summer 1387.
Mojtaba Khazaee and Hamid Raza Izadbakhsh (2010)\textsuperscript{33} in an essay entitled “The complete grading of decision making units with the combination of DEA and PCA” presented a combination model of DEA and PCA in order to present data collection dimensionally. The result of this research shows that although the DEA method is used as an effective instrument for evaluation and sampling, but the number of under evaluation units for increasing the power of distinguishing efficient units from inefficient units should be in accordance with the number of input and output variables.

Meamariani and et al (2006)\textsuperscript{34} in an essay entitled “The comparison of the performance evaluation methods: a mathematics view point” studied the major methods of performance evaluation like European performance model, DEA and balanced point card system from a mathematics view point.

Suhaimi (2005)\textsuperscript{35} in her essay entitled “The expense productivity and knowledge – the economy of trade banks in Malaysia” has tried to clarify the importance of economy – k variables as one of

\begin{enumerate}
  \item \textbullet \textsuperscript{33} Khazaee, Mojtaba, Izadbakhsh, HR, ranking decision making units complete with multiple objective DEA composition and PCA, Journal of Technology Management, Volume 1, Number 2, Spring-Summer 2010
  \item \textsuperscript{34} Meamariani, A., “Comparison of Performance Evaluation methods: a mathematical perspective,” the second national conference on performance management, 2006
  \item \textsuperscript{35} Suhaimi, Rosita. COST EFFICIENCY AND K-ECONOMY OF COMMERCIAL BANKS IN MALAYSIA., University of Teknologi MARA Sarawak, 2005.
\end{enumerate}
the factors of productivity commercial banks. In this research she made use of the special Husman’s test in order to study the exogenous or endogenous of economy – k variables with regards to the special features of the model. The result shows that all three variables of economy – knowledge (efficient infra structures, knowledge labor and the expenses of information technology) are considered as an independent weak variable. This result rejected the endogenous growth theory and moves toward the neo classical theory.

Beccalli and et al (2003)\(^\text{36}\), in an essay entitled “The productivity the performance of stocks in Europe banking” has tried to replace more complete reasons in bank productivity by the use of interest rate definition and evaluating the relation between this rate and market performance in economic institutes. She evaluated banks in Europe list in 2000 by the use of DEA and SFA models. The result shows that the percentage of the stock price changes is a reflection of interest rate.

Fiorentino and et al (2006)\(^\text{37}\) in an essay entitled “Interest in German banks: the comparison between DEA and SFA” evaluated the accordance between the result of productivity from two mentioned methods. The result shows that the non-parametric

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methods are sensitive to measurement errors. In addition, in spite of fundamental changes in Europe banking system, the interest rate ability is very high in short term run.

*Thoraneenitiyan (2009)*\(^{38}\) in a research entitled “The measurement of the effects of renovation and case features of special country in interest after the crisis of banking system in east Asia: by the use of DEA and SFA” concluded that although combining the services of local banks leads to more interests for banks, but renovating does not lead to interest generally.

*Duygun Fethi (2010)*\(^{39}\) in an essay entitled “Evaluating efficiency and bank productivity by operational research and artificial intelligence techniques” studied 196 cases by the use of artificial intelligence in evaluating bank performance component recessively.

*Liadaki and Gagonis (2010)*\(^{40}\) in a research entitled “Interest and the stock performance in European Union banks” have tried to study the relation between the stock performance in Europe list banks and their interest. They made use of SFA method along with controlling environmental factors. The result shows that changing

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interest and profit has positive and significant impact on the stock price, although there is no relation between the changes of expense productivity and stock returns.

**Tabak and Tecles (2010)**⁴¹ in their research entitled “Calculating Bayesian SFA for India banking system” by the use of Bayesian SFA, tried to present an accurate conclusion from both aspects of expense and profit return in India banking sector between 2002 – 2006. The findings of this research show that the governmental banks are more efficient than private and foreign banks. Although, according to the documents of this research, the foreign banks upgraded their profit return level in comparison with their local coworkers.

**Ta and et al (2009)**⁴² in an essay entitled “Upgrading the performance of online banking by the use of DEA and PCA introduced a bilateral approach for measuring the performance of electronic banking. The researcher concluded that identifying operational accordance and trade tendencies of every company will be helpful to identify the strong and weak points of banks in future which try to move towards internet banking.

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Raees Safari and Amiri (2007), in a research studied the efficiency of Iran’s commercial banks and the effective institutional factors on it. In this research, he made use of non-parametric method for studying the efficiency of the Saderat bank heads in provinces of the country and made use of data of 2000 – 2001. The obtained results show that the bank’s officials who try to gather savings by different methods and huge expenses have to be alarmed. The increase of stable capitals in 2001 to 2000 has no positive effect on efficiency in all banks and in some banks; it leads to severe lack of efficiency. Finally, the surplus human resources in almost all banks lead to efficiency of the banks although, its effect was lower than the two other factors, some banks had more rate of outputs with lower number of labor forces which had a significant effect on increasing efficiency.

Ajorlu and et al (2005) in a research studied the expense efficiency in Iran’s banking system. In this research the researcher calculated the expense efficiency of Mellat bank by the use of econometrics parametric technique and translog accidental frontier expense function. The applied model in this study is the variable efficiency model with Bettis and coeli time (1992). The applied

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data in the above research are time series data for the time period of 1992 – 2006.

The results show that Mellat bank had the budget expense inefficiency of 7% during the study period. On the other hand, the procedure of inefficiency during the time shows that the rate of inefficiency was almost stable during the time. In addition, according to the obtained results, Mellat bank can upgrade the expense efficiency by more optimized allocation of resources including labor force, different types of saving and stable capitals.

Suri (2006) in his research studied “The measurement of efficiency in Iran post banks in provinces”. In this research, the researcher has tried to measure efficiency of 28 independent post bank heads and determine effective factors on them by the use of accidental frontier function method (SFA). The applied methods in this research inefficiency model with Betis and coeli with time variable (1992) and the Betis and coeli’s model (1995) used data are for the 2000 – 2006 time period. The results show that the efficiency of heads with the size of post banks (total capital), number of personnel, number of branches and time has a negative relation and has a positive relation with the total income of post banks.


Karimi (2003)\textsuperscript{46} in a research entitled “The study of the efficiency of different branches of agriculture bank and determining the effective factors on it” has tried to calculate the expense (economic efficiency) of different branches of agriculture bank in Hamedan province and determining the effective factors on it by the use of accidental frontier function method. The models are applied in this research are the inefficiency models with Betties and coeli (1992) time variable and Betties and coeli (1995) inefficiency model. The used data in this research are taken from 17 major branches of Hamedan province agriculture banks for the 1991 – 1997 time periods. In this research, the outcome of the branch is the same as total amount of given facilities and the annual average salary for every labor force, the average profit to long term investments saving, the average rate of stable capital maintenance and official expense is considered as institutes. According to the obtained result from the research, the different branches of agriculture banks provide and present bank services with lowest expense on the other hand, the expense efficiency of branches are 79% and 78% by the use of first and second model.

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\textsuperscript{46} Karimi, Mojtaba. *review the various branches of Agricultural Bank performance and determine the factors affecting it (case study of Hamedan province). * MSc thesis economics, Tehran University, 2003.
In the next table, we can see some other related studies to relate to selected of input and output in this study.

**Table (2-2) some Other Related Studies**

<table>
<thead>
<tr>
<th>Author (publication date)</th>
<th>Applied approach</th>
<th>Inputs</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Athanassopoulos (1997) 68 branches of a Greek commercial bank</td>
<td>Production efficiency</td>
<td>number of employees, number of ATM, number of computers</td>
<td>number of deposit accounts, number of credit and debit transactions, number of loan applications</td>
</tr>
<tr>
<td>Camanho and Dyson (2005)</td>
<td>Production efficiency</td>
<td>number of branch and account managers, number of administrative staff, number of tellers, operational expenses</td>
<td>number of general service transactions</td>
</tr>
<tr>
<td>Drake and Howcroft (1994)</td>
<td>Production efficiency</td>
<td>number of ATM, operational costs, space</td>
<td>value of loans, deposits and insurance products</td>
</tr>
<tr>
<td>Gaganis et al (2009)</td>
<td>Cost efficiency</td>
<td>interest expenses, fee expenses, loan loss provisions</td>
<td>interest income, fee income</td>
</tr>
<tr>
<td>Giokas (2008a)</td>
<td>Production efficiency</td>
<td>personnel expenses, other operating expenses</td>
<td>value of deposits and loans, fee income</td>
</tr>
<tr>
<td>Giokas (2008b)</td>
<td>Production efficiency</td>
<td>personnel expenses, other operating expenses</td>
<td>value of deposits and loans, fee income</td>
</tr>
<tr>
<td>Hartman et al. (2001)</td>
<td>Production efficiency</td>
<td>number of employees, number of computer terminals, square meters of premises</td>
<td>value of deposits and loans, value of house mortgages, number of customers</td>
</tr>
<tr>
<td>Noulas et al (2008)</td>
<td>Cost efficiency</td>
<td>number of employees, other operating expenses</td>
<td>value of deposits and loans</td>
</tr>
<tr>
<td>Oral and Yolalan (1990) 20 branches of a Turkish commercial bank</td>
<td>Cost efficiency</td>
<td>personnel expenses, operating expenses, interest expenses, depreciation</td>
<td>interest income, fee income</td>
</tr>
<tr>
<td>Parkan (1987)</td>
<td>Production efficiency</td>
<td>number of employees, other operating expenses, number of terminals</td>
<td>number of credit and debit transactions, number of loan applications, customer service survey rating</td>
</tr>
<tr>
<td>Pastor et al. (2006)</td>
<td>Transaction efficiency</td>
<td>personnel expenses, operating expenses, deposit interest expenses, delinquencies</td>
<td>interest income, value of deposits and assets, number of customers, high – income customers, ROA, profitability</td>
</tr>
<tr>
<td>Portela and Thanassoulis (2007) 57 branches of a</td>
<td>Transaction efficiency</td>
<td>number of ATM, rent, number of clients not registered the</td>
<td>number of new registrations for internet use, number of</td>
</tr>
<tr>
<td>Study</td>
<td>Cost efficiency</td>
<td>Measures</td>
<td>Transactions in automatic machines</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>------------------</td>
<td>------------------------------------------------</td>
<td>-----------------------------------</td>
</tr>
<tr>
<td>Portuguese commercial bank</td>
<td></td>
<td>previous month for internet use transactions in automatic machines</td>
<td></td>
</tr>
<tr>
<td>Vassiloglou and Giokas (1990)</td>
<td>Cost efficiency</td>
<td>number of employees, operational costs, number of computers</td>
<td>number of credit and debit transactions</td>
</tr>
<tr>
<td>Wu et al. (2006)</td>
<td>Cost efficiency</td>
<td>number of employees, operational expenses</td>
<td>value of deposits and loans, fee income</td>
</tr>
<tr>
<td>Aggelopoulos et al. (2010)</td>
<td>Cost efficiency</td>
<td>Personnel expenses, Operational expenses, Loan loss impairments</td>
<td>Net interest income, Non-interest (fee) income (t)</td>
</tr>
</tbody>
</table>
2.8.2. Review of Literature of Credit Scoring Models

2.8.2.1. Introduction

Originally the method used for credit scoring was a purity judgmental approach (2001 LIU)\(^{47}\) although in these models, an extensive spectrum of qualitative variables were used which cannot be used simply in quantitative models. Thus, there is always the possibility of mistakes and errors. On the other hand the increase of credit demand, the increase of competition and the establishment of new channels in the modern economic atmosphere led to the fact that credit giving institute understand the need of making use of new instruments and methods and they are guided toward new technology in credit management process. These models were the most popular quantitative models which were used for rating credit demanding companies. The advanced versions of these models are used in credit rating methods as a powerful and reliable instrument of statistical models which are named Linear Regression and Discriminate Analysis models. In the present time, the application of different types of nerve networks and genetic Algorithm or their combination with fuzzy logic and statistics led to the establishment of powerful models for credit rating by the rapid development of

these models. The carried out researches show how highly accurate are these models in comparison with parametric model (*Shin and Lee, 2002*)\textsuperscript{48}. The descriptive used variables in parametric and non-parametric models were mainly the financial relations of companies in order to rate legal people which are calculated based on financials and the most important reason beyond using them is removing the effect of the companies size rather than financial size.

The obtained of approach models along with statistical models and artificial intelligence which make use of financial relation as variables were developed later on. These models have made use of market variables such as market value of properties, and salary of stock owners of a company as variables. In spite of the relative acceptable accuracy of these models (*Hilliest, et al 2003*)\textsuperscript{49} due to the lack of proper access to the model variables for companies out of stock market, they are used less.

The aim of credit scoring is to predict risk, not to explain it. For most of the last 50 years, the aim has been to predict the risk of a consumer defaulting on a loan. More recently, the approach has been to predict the risk that a consumer will not respond to a

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\textsuperscript{49} Sherlund et al and Hilliest, (2003), Using quick bird imagery and aproduction Efficiency model to improve crop yield estimation in the semi-arid hilly loes plateau, Chind, V8, 722-735
mailing for a new product, the risk that a consumer will not use a credit product, or even the risk that a consumer will move an account to another lender. Whatever the use, the vital point is that credit scoring is a predictor of risk, and it is not a necessary answer to this question as to why some consumers default and others do not. The strength of credit scoring is that its methodology is sound and that the data it uses are empirically derived.

Thus credit-scoring systems are based on the past performance of consumers who are similar to those who will be assessed under the system. This is usually done by taking a sample of past customers who applied for the product as recently as it is possible to have good data on their subsequent performance history.

Nowadays, continuous development dynamic credit industry plays more important role in the economy and creditors to develop a credit management process have used new tools and methods and advanced technologies. Customer’s ability to repay and its assessment techniques and using advanced and modern statistical methods are efforts that have been performed in this field.

Credit scoring means Evaluation and assessment of creditworthiness of applicants and forecast of probability of non repayment of received loans by customer. Accreditation system to customers such as "credit scoring" and "Customer Credit Rating"
have been designed and developed today. (Yang Louie, 2001)\textsuperscript{50}. History to assess credit scoring will return to making money coined Age. In the past, since people borrowed from the various groups and individuals tried to consider their financial ability. In that period the financial factors that affected ability of people were limited to make a decision, thus lending institutions, according to previous experiment made decisions to grant those loans. In any case, the borrower’s financial strength is always one of the important factors to be considered in the past as well as in the present times.

2.8.2.2. Review of Literature of Credit Scoring Models

Credit scoring began with the release of securities at the beginning of the twentieth century. Simultaneous with the release of the first article of these securities, the first survey in connection with the financial ratio analysis as a tool for determining the vigor of companies was published.

The credit scoring began in the 20th century along with the publication of loan papers. The first article in relation with analyzing and interpreting the accounting relations as an instrument for determining the financial capabilities of companies was published in 1909 in which John Mouriie introduced scoring and rating method of credit risk on loan papers. Some researchers had undertaken the study of the similarity of loan papers and given

facilities and had studied the risk measurement of the lack of payment of origin and profit as far as the facilities were concerned.

Financial institutions manage credit risks for businesses and consumers differently. In spite of the fact that procedures for granting loans to businesses are less universal, quantitative business credit scoring models were developed fast (Altman, 1968); (Beaver, 1967) mainly due to a wider availability of company data.

In the past, due to the limited number of usually standardized types of consumer loans and scarce availability of data financial institutions predominantly used simple subjective qualitative methods to evaluate creditworthiness of consumer loan applicants. Quantitative consumer credit scoring models were developed much later than those for business credit mainly due to the problem of availability of data. In many countries legal (privacy protection) and other reasons prevented the buildup of publicly available databases. Data were limited to the own databases of financial institutions. Nowadays, some data are publicly available in several countries and financial institutions and researchers have developed many different quantitative credit scoring techniques.

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Classical statistical methods that are used to develop credit scoring models are linear discriminate analysis, linear regression, logit, probit, tobit, binary tree and minimum method.

The weakness of the linear discriminate analysis is the assumption of linear relationship between variables, which is usually nonlinear and the sensitivity to the deviations from the multivariate normality assumption. The logistic regression is predicting dichotomous outcomes and linear relationship between variables in the exponent of the logistic function, but does not require the multivariate normality assumption. Because of the linear relationship between variables both LDA and logistical regression are reported to have a lack of accuracy. On the other hand there are also studies showing that most of the consumer credit scoring datasets are only weakly nonlinear and because of that LDA and logistical regression gave good performance.

There are also more sophisticated models known as artificial intelligence: expert systems, fuzzy systems, neural networks and genetic algorithms. Among these the neural networks are very promising and the alternative to the LDA and logistic regression, due to the possible complex nonlinear relationship between variables. In the literature in most cases of credit scoring problems the neural networks are more accurate than LDA and logistic regression (Lee et al., 2002). The neural networks have their weaknesses in their long training process, and after obtaining the
optimal network’s architecture, the model acts as a “black box” and there is not easy to identify the relative importance of potential input variables. In the last years such systems seem to be the most promising (Shin and Lee et al., 2002)\textsuperscript{53}.

Danhum (1938)\textsuperscript{54} was the first person who presented a system for applying credit cases in which five indexes were used including: the present condition, income situation, financial situation, guarantee and assurances and recovery information of given facilities from the other banks which were the indexes.

Durand (1941)\textsuperscript{55} had tried to understand which variables are important in borrower’s point of view and what feature are significant statistically. He was the first to use separated analysis and interpretation based on fishers result. He introduced the development of theoretical framework in such a way. In addition, he presented some advice to analyze credit risk. In the late (1950), more companies were eager to improve and upgrade credit scoring system. The advanced activities in this field are established by the biggest the most famous company, Fair Isaac Sanfrancisco by Bill Fair and Earl Isaac in the early 1956.

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55 Durand., (1941), Risk element in consumer installment lending, national bureau of economic research, NEW YORK, vol, study # 8.
Boggess (1967)\textsuperscript{56} was the first to point out the use of computer to analyze big set of data from different points of view and tried to use complicated multivariable statistical instrument which is a leader for the formation of accurate credit scoring models of combined studies. The article of Beaver (1967)\textsuperscript{57} can be mentioned about calculating success and default of companies by the use of some financial indexes.

Deakin (1972)\textsuperscript{58} used “z score analysis method” for evaluating the default of companies by the use of 14 financial relations as independent variables and evaluating the performance of companies by the use of the model.

Morgan (1994)\textsuperscript{59} designed the models for credit risk measurement. Treacy (1998)\textsuperscript{60} designed the model of value in danger for determining the function of probable lack of recovery. There were the earliest researchers in this field. In 1970, several American and European Banks went bankrupt and the importance of the event led to the study of the reasons and factors behind this incident by the

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\textsuperscript{56} Boggess W.B., (1967) "Screen-test your credit risk" Harvard Business Review


\textsuperscript{60} Treacy, William F., Mark S.Carey, (1998) "Credit risk rating at large u.s.banks", Federal Reserve bulletin, Board of governors of The Federal Reserve system.
other banks. Regarding the analysis and interpretation of about 20 bankrupt banks the major reasons of bankruptcy were giving high risk facilities behind the economic crisis of that period were identified.

Pomberton Will and Poud Welker (1986), the former founders of the Basel Committee and America Reserve Federal had some debates in an informal session about banks challenges and minimum banks capital. This session can be considered as the first stage of forming the credit risk and capital efficiency regulations. In January 1998 and after frequent negotiations among group ten members, the banking regulations committee and supervising banking operations, the methods of bank capital calculation and legal minimum rate of capital for covering risk were determined and the results were announced to active related international banks.

Mure and Klein were the first researchers who wrote in relation with now to connect factors to the performance of variables which are changing as the time passes.

(Altman 1968)⁶¹, in order to evaluate the success of companies used of Z score model.

There is a parallel development to credit scoring in using scoring approaches to predict the risk of companies going

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bankrupt. Although this has provided some interesting results connecting accounting ratios to subsequent bankruptcy, because samples are so much smaller than in consumer credit and because accounting information is open to manipulation by managers, the predictions are less accurate than for the consumer credit case.

Most of the variables used have obvious connections with default risk. This led to a debate in the early 1980s about the ethics of credit scoring between those (Nevin and Churchill 1979)\(^62\), (Saunders 1985)\(^63\) who advocated it and those (Capon 1982)\(^64\) who were critical of its philosophy and implementation compared with the subjective judgmental systems based on credit analysis and underwriters’ opinions. Many of them described the advantages of credit scoring as its ability to maximize the risk-reward trade-off, that it gave managerial control of this trade-off, and that it is efficient at processing applications.

The soundness of the statistical methodology was criticized because of the bias in the sample used, which does not include those who were previously rejected. The appropriate size of a sample was questioned, as was the problem of overriding the systems decisions. Other problems highlighted were the co

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linearity between the variables and the discontinuities that cause classifying introduced into continuous variables. The credit-scoring industry has long been aware of these criticisms and either has found ways to overcome any deficiency or allows for them in its decision making.

The overwhelming point is that in the 20 years since this debate took place, scoring systems have been introduced for many different consumer lending products by many different types of lending organizations all over the world, and the results have almost always given significant improvements in the risk return trade off.

Five decades late, more financial companies and institution willing to improve the credit scoring systems. Leading activities in this field established by the most famous companies, Fair Isaac San Francisco by Bill Fair and Earl Isaac in the early 1950s. **Beaver (1967)** studies factor of success and failure in companies with some financial indicators.

Originally, the methods used for credit scoring was a purely judgmental approach (**2001, LIU**).

Although these models were in a range of qualitative and quantitative variables that simply cannot be used but

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when these organizations used credit scoring they found that it also was a much better predictor than any judgmental scheme and default rates would drop by 50% or more (Myers 1963). In the 1980s the success of credit scoring in credit cards meant that banks started using scoring for their other products like personal loans.

Advances in computing allowed other techniques to be tried to build scorecards. In the 80s, logistic regression, linear programming and discriminate analysis were the main stalwarts to credit scoring that were introduced.

These models were used as the most popular models typically to rank companies. Advanced various ways of these models are still used in credit scoring as a strong and reliable tool. More recently, Artificial Intelligence techniques like expert systems, neural networks, and genetic algorithms and nearest neighbor have been piloted. Credit scoring also lends itself to a number of different non-parametric statistical and modelling approaches.

Shin and Lee (2002) suggest non parametric model has a higher accuracy than the parametric models

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Altman for the first time in 1967\textsuperscript{69}, used the discriminate analysis model used for corporate bankruptcy and took a job based on new definition of bankruptcy and then the model was reviewed in 1977. His own model in 1995 for emerging markets was also implemented in 2000 and recently these models using new data have been updated. Altman (2000)\textsuperscript{70} using 66 financial ratios, including bankrupt companies (33 companies) and unbankrupt (33 companies) had attempted to estimate by the discriminate analysis model. Among the 22 existing financial outcome, five variables with the highest strength accuracy (95 percent) were selected. The estimated coefficients using this model for 25 companies out of sample had been suffering from 96 percent accuracy from which the model is derived.

Emel et al (2003)\textsuperscript{71} have used DEA model for 82 company’s credit information from one of Turkey's private commercial banks. They were categories both good and bad groups. First, using the DEA model efficiency coefficient for the credit companies was calculated. Their financial ratios that they used the input of model include:

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\textsuperscript{69} Altman EI, (1968) , "Financial ratios discriminate analysis & The prediction of corporate bankruptcy” The Journal of finance XXIII
(Current debt / short-term loans), (net sales / current debts) and 
{(equity/fixedassets)-1}
and output of model includes:

{Current debt / (listed property - current assets)}, (total assets / equity) and (total assets/net profit).

After obtaining the coefficients of efficiency, based on their distribution into two equal groups (each group, 41 companies) were divided. Also their results were compared with three methods; linear regression, discriminate analysis and comparison of these banks, experts judged. Their results show the result of DEA model had matched to 78 percent with bank experts and linear regression analysis and to 92 percent with discriminate analysis.

Hayden (2003) in a study in Austrian companies was using the logit prediction model, by using logit model, he estimated probability of bankruptcy, overdue and delay in repayment of more than 90 days.

Then he has selected first 65 major financial ratios from financial statements companies and after extraction of linearity (is a important assumption in Logit, model to estimate) estimate Univariate models for each of these ratios. Then, by using the cumulative accuracy Univariate models to

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cumulative model, the importance of each of the variables in the model is derived. According to these models to predict bankruptcy, debt to assets ratio and in two other models equity to assets ratio as the most important variables identified and based on these ratios grouping has been done.

Finally, Logit multivariate model based on estimated final classification and prediction models for each of these events is derived. To test the predictive accuracy of models, the accuracy factor model calculated for the samples and a number of companies which were separated as data out of the samples.

The calculated results are presented in the following table:

**Table 2.3: calculated results of Legit multivariate model.**

<table>
<thead>
<tr>
<th></th>
<th>Delay model</th>
<th>Overdue model</th>
<th>Bankruptcy model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy for inside of sample</td>
<td>50.3%</td>
<td>59.9%</td>
<td>60.6%</td>
</tr>
<tr>
<td>Accuracy for outside of sample</td>
<td>48.8%</td>
<td>58.5%</td>
<td>58.8%</td>
</tr>
</tbody>
</table>

Obviously, the obtained models only show probability of financial crises and probability calculated for each company as the main factor in credit scoring is used. In fact some threshold is determined for each rank, the applicant company credits can be
obtained based on the amount likely to be ranked. Malhotra (2003) in his article “ANN method used”. The use of the back propagations were attempted to classify 12 financial institutions customer in the U.S. The model is divided into two groups of samples which are good and bad. They had reimbursed to customers who default have been placed in bad and customers who have repaid on maturity are placed in good group.

From the 1078 samples, 378 samples randomly selected to measure fitness of models were excluded from the remaining 700 samples which were used for the education system. X vector profile that is used here includes six variables: residential home ownership, length of stay in current location, credit card, the total payments to total revenue, the ratio of total debt to total revenue and customer credit rating as an exogenous variable. Training samples randomly into five groups and each group of two subgroups were divided into good and bad, and separate models for each group was planned. The results show that prediction accuracy equivalent to 70 to 77 for training sample and 68 percent to 74 percent in the experimental group (378 customer outside the sample) is derived. Comparison of the results of multivariate discriminate analysis showed that significantly predicted accuracy of ANN models is higher (about 4 percent).

Shin and Lee (2002)\textsuperscript{74} have applied genetic algorithms in credit scoring by using financial statements audited by 528 medium-sized industrial companies in the years 1995-1997 to estimate the probability of bankruptcy. Among the 55 available financial ratios are selected 9 of those by using factor analysis and applied the genetic algorithm to it. They have obtained five rules which were from the model and each of the five rules only uses financial ratio. Any form of rule in this case is defined as a threshold that if the 5 ratios value for these companies are placed under the threshold that the company is considered on the verge of bankruptcy. Test results for 52 companies, which firms as outside the sample were considered, the model shows that on average 80 percent were correctly predicted.

Michael, et al (2003)\textsuperscript{75} “Classification of fuzzy rules” - the basis for predicting bankruptcy has been used, they work with 12 financial ratio of 80 Greek companies (40 bankrupt companies and 40 non-bankrupt companies), that since five years before their current status was collected, were predicted bankruptcy by fuzzy rules. Their results show that the obtained models for predicting bankruptcy for inside of sample companies have only 1.25 percent error and for companies outside of sample have 36/84 percent

\begin{enumerate}
\item \textsuperscript{1.}
\end{enumerate}

\textsuperscript{74} Shin, myung chul. seok hun lee, (2002). Improvement of flocculating efficiency of water triment by using polymer flocculants environmental technology, V19, 431-436.
error and for whatever period of time longer it is expected to have error increases.

Hillegeist et al (2004) noted that using the Black-Scholes-Merton option pricing theory (BSM-Prob) the probability of bankruptcy have been calculated for 14,303 company during the years 1962-1992. Their probabilities obtained from the model were compared with four different models and showed a significant accuracy of the model probabilities obtained from the results of BSM-Prob is higher than four other models.

After statistical models in recent years structural forms and reduced forms have been evaluated.

In these models default as an endogenous factor is defined when default that occurs that the ratio of assets to debt is much less in certain measure. The simplest case is that every time that the assets are less than capital default occurs.

While the first structural models of default risk structure known articles Fisher Black and Merton Scholes (1973) and Robert C Merton (1974) have introduced this model and articles Jarrow and Turnbull(1995,1992) are also.

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Zekavat (2004)\(^{77}\) in his M.A thesis on “Banking Sciences Management of Iran” has studied the credit risk models of customers of export developing bank by the use of financial relations and indexes and Altman model in which he made use of regression and discrimination analysis method. According to this, he selected five financial relations which have meaningful effects on the separation between two groups of good and bad customers as descriptive variable and analyzed the effect of each one.

Musavi, Ebtehaj (2008)\(^{78}\) in his M.A thesis in banking sciences entitled “The study of the effective factors on customers’ credit rating” in 2008 and believed that: banks play the major role in financial providence of different economic sections. They are encountered with different risks in order to playing this role in which one of the major one is credit risk. There should be proper understanding and awareness of credit customers in order to manage and control this risk. One of the most important instruments for doing so is to access credit measurement system and credit scoring of customer. He studied the effective factors on customer credit rating in this research. The major research hypothesis was, whether there is a meaningful relation between individual indexes of customers and credit given to risk or not?

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\(^{77}\) Zekavt, Seyed Morteza, customer credit risk models EDBI, MS Thesis Banking Institute, September 2004

\(^{78}\) Mousavi, Ebtehaj, review the factors affecting credit rating of customers, management science master’s thesis Bank, 2008.
Which divided into 14 minor hypotheses? Collecting data was carried out by the use of library method and questionnaire method as illustrated in the third chapter of his thesis in which 363 customers’ facility profiles of Khorasan e Razavi Export Bank. Data analysis and interpretation was carried out by Logit methods in which the result of the study shows the reliability of this hypothesis that there is a meaningful relation between customers’ individual indexes and credit given risk. In addition the effective factors on credit given risk to legal customers were identified and announced.

Khavari and Amiri (2005)\textsuperscript{79} in an essay entitled “A method for credit measurement and credit rating of banks customers” in 2005 have presented a model in order to find out credit rating of real and legal customers in aSepah Bank. Different factors are considered for scoring to each one of the essential indexes in given facilities in rating real customers and the score and final rate of customers are calculated. The rating of legal persons were carried out in qualitative and quantitative frame works in which their analysis based on AHP method and the quantitative characteristics based on financial features and their analysis in data enveloping analysis are analyzed and interpreted.

Shams Fallah and Tehrani(2006)\textsuperscript{80} in an essay entitled “The designation and determination of credit risk model in the country banking system” in 2006 have studied the efficiency of linear, logistic and artificial neural networks probable models in order to predict the credit risk of customers in the country banking system. The predictive variables in these models were the financial relations of borrowers in which their meaningful relation were confirmed by credit risk via proper statistical tests. The mentioned models were designed and tested by the use of financial and credit data of 316 legal customers of the country banks. The obtained results of this research show that the relation between variables was not linear in the model of credit risk prediction and Sigmoid Functions are counted as the most proper models of credit risk prediction. The highest efficiency for predicting credit risk was related to artificial nerve networks and logistic model.

Arab Mazar and Rueentan(2007)\textsuperscript{81} in a research entitled “The effective factors on credit risk on bank customers (about Agriculture Bank)” in 2007 have introduced a model for credit risk measurement of legal customers in Iran Agriculture Bank by the use of Logit Regression method in order to identify the effective factors. The qualitative and financial data of a random

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\textsuperscript{80} Falah Shams, Mir Faiz and Tehrani (2006). Design and credit risk models in explaining the country's banking system, Journal of Social Sciences and Humanities, Shiraz University, Volume 22, Number 2, 2006.

sample are studied, includes 200 companies which received financial facilities during 2002-2007 from Agriculture Bank branches in Tehran. In this research, the 36 descriptive variables including financial and qualitative variables are identified and studied after studying credit profiles of each sample and finally 17 variables which were effective on credit risk and the two groups of good and bad customers, are selected and the final model was processed by them by the use of Logit Regression analysis. According to statistical indexes, these functions are meaningful and highly reliable regarding the indexes as well as their power of separation. The results of the research show that the effective factors on credit risk of legal customers of Agriculture Bank have much in common with the effective factors on credit risk of legal customers of the other banks such as Mellat Bank and Export Development Bank.

Khalili Araghi(2006) in an essay entitled “Credit risk management by applying decision making models” have studied the important financial relations and indexes in rating bank customers as the following table shows by the use of multi index decision making method particularly TOPSIS Method.

1. 

Mansouri (2004)\textsuperscript{83} in his doctoral thesis entitled “Designing and determining the mathematical model of bank allocation facilities” in financial management at Tarbiat Modares University has presented two models of regression and neural networks in order to measure credit risk and Mellat Bank customers and then, their efficiency were compared.

Mahdavi Rad (2008)\textsuperscript{84}, in his M.A thesis entitled “Designing credit measurement model and predicting credit risk of leasing facilities customers (case study: Iran Khodro Leasing company)” in Imam Sadegh University in 2008, believed that leasing company has a very high profitability regarding the nature of rental activities and has the most challenges on the other hand. Some of the most important challenges of leasing companies include credit risk, trade risk, remain value risk and exchange rate risk in which, credit risk is considered as the most important risk among all. Generally, establishing logical relation between risk and output will be the major factor of optimized allocation in which it will be highly responsible for the profitability of leasing company. In this thesis, the leasing industry and the related types of risk with emphasis on econometrics model of Logit and Probit are studied at first. Thereafter, the credit risk model of legal customers of leasing

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\textsuperscript{83} - Mansoori, Ali, design and mathematical models explaining allocation of bank facilities (the classical approach and neural network models), PhD thesis management Tarbiat Modares University, 2004.

\textsuperscript{84} - Mahdavi Rad, Hamid, design validation and forecasting models of credit risk customers leasing facilities, M.Sc. Thesis University of Imam Sadeq, 2008
facilities is designed and the real amounts of risk are compared with the predicted amounts by the model after that in which the result shows that Logit model has less predicting errors than Probit model and thus, the efficiency of Logit model is higher than Probit model.