

## Predicting Banks' Financial Distress by Data Envelopment Analysis Model and CAMELS Indicators

**Gholamabbas Paidar**<sup>1</sup>

**Morteza Shafiee**<sup>2</sup>

**Fariborz Avazzadeh Fath**<sup>3</sup>

**Hashem Valipour**<sup>4</sup>

### Abstract

Due to their inherent nature in the economy, banks have a fundamental and significant responsibility for capital formation. Therefore, evaluating their performance can help decision makers find the optimal solution and prevent financial distress. The purpose of this study is to evaluate the performance and forecast financial distress of banks listed on the Tehran Stock Exchange, based on CAMELS indicators and Data Envelopment Analysis model. First, using the data of 17 banks in the fiscal year 2018, 5 levels of determining the health of banks, in the form of differences between the performance of these banks in terms of capital adequacy, quality of assets, quality of management, Earning and liquidity and sensitivity to market risk, It was found. And the studied banks were divided into two groups: healthy and helpless, based on CAMELS indices. Then, according to the effects of financial distress on banks, financial distress was predicted by Data Envelopment Analysis model slacks-based on measure of efficiency (SBM) and with a different approach. The results show that 61% of the predictions were correct by DEA technique and 39% of them were incorrect. Also, the results of this study showed

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<sup>1</sup> Department of Accounting and Management, Yasuj Branch, Islamic Azad University, Yasuj, Iran

<sup>2</sup> Department of Management, Shiraz Branch, Islamic Azad University, Shiraz, Iran, Correspond Author : ma.shafiee277@gmail.com

<sup>3</sup> Department of Accounting, Gachsaran Branch, Islamic Azad University, Gachsaran, Iran

<sup>4</sup> Department of Accounting, Firuzabad Branch, Islamic Azad University, Firuzabad, Iran

that CAMELS financial ratios can be a good assessor for banks' financial distress.

**Keywords** *Financial Distress Prediction, Data Envelopment Analysis, Banking Health and Stability, CAMELS Indices, Banking Supervision*

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### Introduction

Banks play a key role in the economy and business environment and in Iran are the major part of national markets (TaHERI et al., 2019). In fact, the structure of ownership of banks and their fundamental role in the national economy is a vital variable in the process of financial development and economic growth. (Soleimani et al., 2020). On the other hand, the Iranian banking system has changed since the Islamic Revolution, all private banks have been left out of the market, and state-owned banks have continued to operate. Over time, it became clear that "government management" in the "banking sector" also did not have the same efficiency as "government management" in other sectors. Therefore, the beginning of the private sector in the banking system from 2001 onwards, as well as the adoption of the general policies of Article 44 of the Constitution, increased the role of the private sector in the economy and promoted the Bank system (Nemati and Tabatabaee, 2016). Privatization has expanded into many areas, and the Bank sector has also had a large presence in this area, with Melat bank being the first government bank to be able to accept the terms of the Tehran Stock Exchange was located. A few months after that, "Tejarat Banks" and "Saderat Banks" appeared as the second and third state-owned banks in the private sector and the Tehran Stock Exchange. At present, 31 banks are members of banks listed on the Tehran Stock Exchange. Banks, on the other hand, are financial intermediaries, most of whose liabilities are short-term deposits and usually their assets, long-term loans to businesses and consumers. Therefore, when the value of banks' assets is less than the value of their debts, banks are unable to pay their debts and eventually

suffer financial hardship (Hasas Yehaneh et al., 2018). And considering that in the bank-oriented economy of the country, about 90% of the total liquidity is managed by banks. And almost every year, banks are at the top of the list of the top 100 companies in the country in terms of various indicators such as revenue (sales), so their performance directly affects the interests of groups of shareholders, depositors, borrowers, customers and all units the country's economy is effective (Soleimani et al., 2020). In such a case, it is necessary to evaluate the performance of banks. Because by identifying the problems that lead to financial helplessness, it is possible to solve the problems that lead to financial helplessness of banks in a timely manner. And helped protect their interests before facing financial distress (Condello et al., 2017). Therefore, one of the methods that can be used to help take advantage of investment opportunities and better allocation of resources is to predict financial helplessness or bankruptcy of organizations. Because by predicting financial helplessness, we can first warn organizations about the occurrence of financial helplessness by providing the necessary warnings so that they can take appropriate actions according to these warnings. Second, all investors should distinguish favorable investment opportunities from unfavorable opportunities and invest their resources in appropriate opportunities (Mehrani et al., 2005). Therefore, the need for timely diagnosis of financial helplessness or financial crisis in organizations, especially banks, is very important, because the soundness of the banking system leads to maintaining the stability of society, monetary system, depositors' interests and maintaining public trust. And requires the supervision of the competent authorities, especially the Central Bank of the Islamic Republic. It is necessary to review, evaluate and interpret correctly and logically the activities performed in banks by the central bank to identify, correct and eliminate potential risks and prevent violations of the banking system. It also helps stakeholders to compare the performance of banks and choose the best option for investment in order to better allocate the country's financial resources.

### Background

Assessing the performance of the banking sector is an effective measure for the correctness of economic activities in the economy. Today, the importance of the banking industry in the country's economy is not hidden from anyone, increasing competition and the existence of new business opportunities for banks and financial institutions have made them need to use new tools and technologies for credit management. The use of rating models provides the information required by banks in effective credit management. In Iran, until the last two decades, due to the statehood of most banks and their small number and the existence of a relatively monopoly market for banks, evaluating their performance was not very important, but due to the significant increase in these institutions and private The merger of most banks seems to be of great importance in evaluating their performance and ranking them (Islami et al., 2011). Since banks, like all other for-profit institutions, seek to maximize their profits, it is essential to use financial metrics to operate them. On the other hand, the operating structure of banks is such that they face several risks, including the risk of non-receipt of receivables, so evaluating the performance of the bank has been a complex issue. It has been discussed and researched by international thinkers and financial institutions for many years. The solution proposed by years of research and review by financial and international institutions, including the Basel Committee on Banking Supervision (BCBS) to evaluate the performance of banks, is the use of CAMELS indicators. Credit rating, profitability and liquidity are among the most important criteria for determining the competency and measuring the performance of a financial institution. To this end, the Camel rating system was first approved by the Federal Financial Institutions Examination Council's (FFIEC) in the United States in 1979 and is used by US banking industry regulators and rating agencies. The word CAMELS is derived from the initials capital adequacy (C), asset quality (A), management (M), earning (E), liquidity (L). In 1996, in an effort to establish a risk-focused rating system, the US

Federal Reserve added S to the index, changing it to CAMELS, where the letter S stands for market risk sensitivity(S) (Roman and Sargu, 2013). In CAMELS method, the rank of banks is determined between one and five. A rating of 1 indicates the best rating and a rating of 5 indicates the worst rating. After determining the rank of each bank in each sub-chapter, the rank of each bank in each heading is determined and finally the rank of the bank is determined between one and five. How to rank banks in banking health indicators are presented in Table1.

Table 1.

*Banking Ranking System with Banking Health Indicators (CAMELS)*

Rank	Analyze each rank	Interpret each rank
1	Excellent	The institution is financially sound in all respects.
2	Satisfactory	The institution is fundamentally healthy, but in some respects it has weaknesses.
3	Medium	The institution has financial, operational and executive weaknesses and needs to be monitored.
4	Weak	The institution has serious financial weaknesses and its continuation is in danger.
5	Critical	The institution is in a critical position in terms of financial weakness and is likely to go bankrupt in the near future.

Therefore, in this study, the criterion of financial helplessness is the rating with CAMELS indexes and by using the CAMELS rating method, the supervisory rating system has been designed for the banks accepted in the Tehran Stock Exchange. The following are the most important foreign researches related to the research topic in Table 2.

Table 2

*Background of Foreign Research*

<b>Alfiyanti and et al (2020)</b>	They Predicted the helplessness of food companies listed on the Indonesia Stock Exchange from 2014 to 2018. In this study, they used Altman and Springate Models, which concluded that Altman model with 86.16% prediction accuracy has a higher level of
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confidence than Springate model with 75.39% accuracy.

<b>Chairunesia and Bintara(2019)</b>	They One study examined the impact of good corporate governance and financial distress on earnings management in Indonesian companies. In addition to examining the impact of corporate governance and financial distress on earnings management, this study examines the relationship between corporate governance and financial distress. They concluded that there is a correlation between corporate governance and financial distress, and that the implementation of good corporate governance principles can greatly reduce the occurrence of financial distress among the companies under review.
<b>Idrees and Qayyum(2018)</b>	They One study examined the impact of financial distress risk on the stock returns of non-financial corporations. The results showed that the risk of financial distress has a positive and significant effect on the stock value of the companies under study and in this, the inefficiency of corporate management in market control plays an important role.
<b>Chiaramontea and Casu(2017)</b>	They examined the effect of liquidity ratios and capital ratios on predicting companies' financial distress. They showed that by improving the liquidity situation and property and capital ratios, the probability of financial helplessness decreases.
<b>Kamrul(2016)</b>	He In a study, measuring the financial performance of Islamic banks in Bangladesh using CAMELS indicators such as capital adequacy, asset quality and management performance in three Islamic banks. The result was that these banks performed better than other banks.
<b>Masood and et al.(2016)</b>	They examined the acceptance of CAMELS indices in Islamic banks of Pakistan. The results showed that the Islamic banks of Pakistan formulate their strategies to comply with and apply the CAMELS indicators and guidelines.
<b>Ahsan(2016)</b>	Using the CAMELS rating method, he has defined a supervisory rating method for Bangladeshi banks. In this article, banks are divided into two groups; The banks that provide Islamic services and the banks that provide non-Islamic services. The results of the study indicate a better ranking of Islamic banks compared to other banks. To rank CAMELS, it tried to give banks a score of one to five in each index of each CAMELS heading. Rank 1 has the best performance and rank 5 has the worst performance.
<b>Muhmada and Hashima (2015)</b>	They used CAMEL indicators to evaluate the performance of domestic and foreign Malaysian banks. The results of the study show that capital adequacy, asset quality, income quality and liquidity have a significant effect on the performance of Malaysian banks.



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<b>Salhuteru and Wattimena (2015)</b>	They examined and compared the performance of public and private banks in earnings management in Indonesia based on the CAMELS model and the results show that in state-owned banks, net profit margin has a positive and significant effect on earnings management while the ratio of capital adequacy and market risk. They have a negative and significant effect on the bank's profit management. In private banks, net profit margin and return on assets have a positive and significant effect on earnings management, and the capital adequacy ratio and the loan-to-deposit ratio have a negative impact on earnings management.
<b>Trivedi and Elahi (2015)</b>	They used CAMELS indicators to evaluate and rank the performance of public and private banks in India. The results showed that private banks have a better performance rating than state-owned banks.
<b>Madishetti (2013)</b>	In a study entitled The Ownership Structure and Financial Performance of Commercial Banks, he compared the two major banks in Tanzania. His research period was between 2006 and 2011. The researcher used t-test to examine any significant differences between the selected CAMEL ratios. This study showed that there is a significant difference between the performance of both Banks in all CAMEL ratios used except return on assets.
<b>Prasad and Ravinder (2012)</b>	In a study entitled Using the CAMEL Model to Analyze Banks, they ranked Indian banks. And evaluated important parameters of the bank such as capital adequacy, asset quality, management, income and liquidity. Their research sample consisted of 20 Indian banks and their research period was from 2005 to 2010 for 5 years. The results of their research show what position and rank each bank has in terms of each parameter.
<b>Rehana and Saba(2012)</b>	Using the CAMEL model, they compared the financial performance of Islamic banks with commercial and mixed banks in Pakistan. They state that CAMEL is a suitable and simple model for financial and managerial evaluation of institutions and institutions. Also, their statistical results show that there is a significant difference in CAMEL ratios for these three types of banks.
<b>Oztorul(2011)</b>	They ranked Turkish commercial banks using the CAMELS model and measured their performance and productivity. The results of this study showed that those banks that have a better rating also have higher performance and productivity.

Also, the most important internal research related to the research topic is given in Table 3.

Table 3

*Background of Internal Research*

<b>Soleimani et al. (2020)</b>	They evaluated the performance of private banks in the Tehran Stock Exchange based on the CAMEL model, during the years 2007-2016. In the form of five hypotheses, they examined the differences between the performance of commercial banks in terms of capital adequacy, assets quality, management quality, Earning and liquidity before and after privatization. It was found that there was no significant difference between capital adequacy and asset quality indicators in the two periods before and after privatization, but there was a significant difference between management quality, Earning and liquidity before and after privatization.
<b>Atefifar and fathi(2020)</b>	They examined the effectiveness of financial health indicators (CAMEL) as symbols of the banking financial crisis, using multivariate logit models in banks listed on the Tehran Stock Exchange. For this purpose, among the banks listed on the stock exchange, 9 banks were selected for the sample and logistic regression was used to analyze the findings. They also used the fuzzy technique for the AHP technique and for prioritizing the main criteria. Based on the statistical results of the logit model, only 4 financial ratios among the CAMEL ratios introduced were effective in the correct ranking of the studied banks.
<b>Yakideh and et al.(2018)</b>	They ranked the country's banks based on CAMEL indicators using the RAM data envelopment analysis model. In order to evaluate and evaluate the performance of banks, financial ratios extracted from banks' financial statements have been used. These ratios have been collected to cover 5 characteristics called CAMEL, namely capital adequacy, asset quality, management, profitability and liquidity. According to the results of the research, Tejarat, Karafarin, Dey, Sina and Pasargad banks are the five banks that had the highest efficiency among the 12 selected banks.
<b>Ramezani et al. (2017)</b>	They predicted the health of selected Iranian banks by Camels indicators and the results showed that 70% of the designed model has made a correct prediction.
<b>Soudani (2017)</b>	He ranked banks and financial institutions, based on CAMELS international indicators and the results showed that EghtesadeNovin Bank was recognized as the best bank in terms of ranking model with CAMELS international indicators.
<b>khanifar et al. (2015)</b>	They to study and compare the financial performance of commercial, public and private banks based on Camel model in the period from 2006 to 2009, The results showed that the performance of private banks in terms of liquidity and income is better than state-owned banks and the performance of state-owned banks is better in terms of management quality.



### Method

The present research is an applied research in terms of purpose. Applied research is research that uses the theories, regularities, principles, and techniques developed in basic research to solve practical and real problems. This type of research focuses more on the most effective action and pays less attention to the causes. This emphasis is further due to the fact that applied research is directed towards the practical application of knowledge. Also, according to the division of scientific research from different perspectives, this research is based on the quasi-empirical nature of capital market data analysis, and considering that to show the efficiency of data envelopment analysis model and theoretical findings from the ranking of banks With CAMELS indices, it has been used practically and in real conditions in Tehran Stock Exchange Organization, so the research method is Case - field. The statistical population of this research includes 17 banks listed in the Tehran Stock Exchange in the fiscal year 2018, and considering that the entire statistical population has been used in this research, no sampling has been done in this research. Therefore, the statistical population is equal to the statistical sample and includes the banks in Table 4.

Table 4

*List of Banks Evaluated in the Research*

Bank type	Website address Bank	Bank name type NGOs	Row
NGOs	<a href="https://melalbank.ir/">https://melalbank.ir/</a>	Mellal	1
NGOs	<a href="http://www.enbank.ir">http://www.enbank.ir</a>	Eghtesad novin	2
NGOs	<a href="http://www.ansarbank.com">http://www.ansarbank.com</a>	Ansar	3
NGOs	<a href="http://www.izbank.ir">http://www.izbank.ir</a>	Iran zamin	4
NGOs	<a href="http://www.parsian-bank.com">http://www.parsian-bank.com</a>	Parsian	5
NGOs	<a href="http://www.bpi.ir">http://www.bpi.ir</a>	Pasargad	6
NGOs	<a href="http://www.tejaratbank.ir">http://www.tejaratbank.ir</a>	Tejarat	7
NGOs	<a href="http://www.hibank24.com">http://www.hibank24.com</a>	Hekmat Iranian	8
NGOs	<a href="http://www.bank-day.ir">http://www.bank-day.ir</a>	Dey	9
NGOs	<a href="http://www.sb24.com">http://www.sb24.com</a>	Saman	10

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Bank type	Website address Bank	Bank name type NGOs	Row
NGOs	http://www.sbank.ir	Sarmaye	11
NGOs	http://www.sinabank.ir	Sina	12
NGOs	http://www.bsi.ir	Saderat	13
NGOs	http://www.karafarinbank.com	Karafarin	14
NGOs	http://www.tourismbank.ir	Gardesh	15
NGOs	http://www.bankmellat.ir	Mellat	16
Government Commercial	http://www.postbank.ir	Post Bank	17

Also, the method of this research is field and library and it uses the information of banks, so the data related to the research variables are collected using the information reported in the financial statements of the banks participating in the Tehran Stock Exchange. Therefore, the steps of conducting research are as shown in Figure 1.

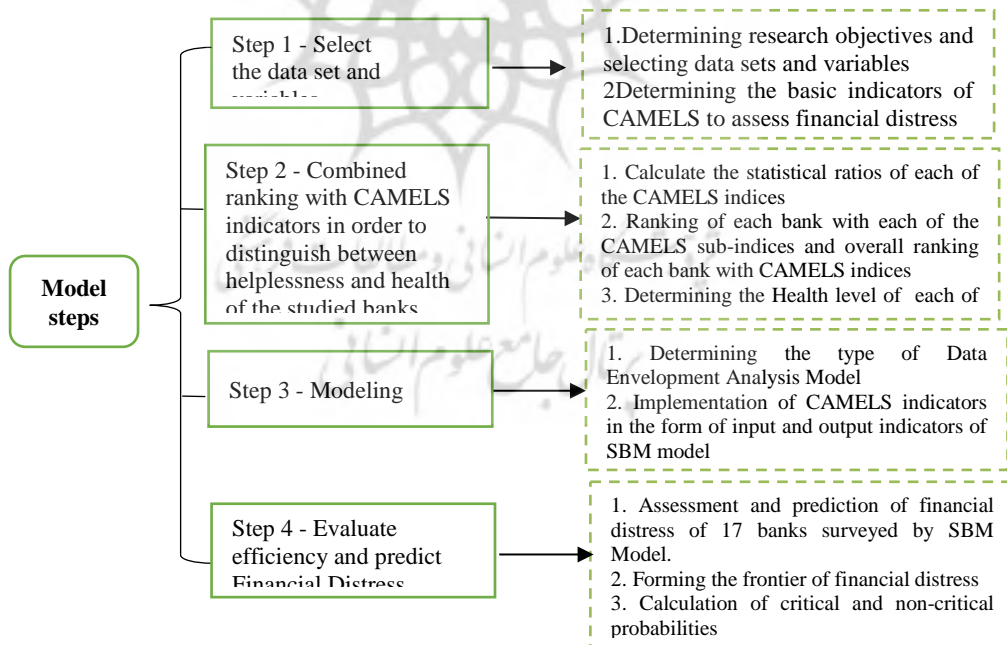


Figure 1  
*Steps of Research*

Also, using the collected data and studying the research literature in this field and examining the opinions of experts in the field of money market and university professors and consulting on the importance of CAMELS indicators, twelve ratios related to CAMELS model have been calculated and banks are ranked for financial performance on the basis of these ratios. The following table 5 depicts the ratios used in CAMELS model.

Table 5.  
*Ratios Used in the CAMELS Model*

Ratio	Measurement
Capital Adequacy	1- Ratio of capital to risk-weighted assets (capital adequacy): $E = \text{bank capital base} / \text{asset weighted risk}$ 2- Ratio of shareholders' equity to total assets (ownership): $F = \text{Owners equity} / \text{Total Assets}$
Asset Quality	1- Debt ratio: $A = \text{total debt} / \text{total assets}$ 2-The ratio of non-current receivables to the total facilities: $B = \text{current non-receivables} / \text{total facilities}$
Management Efficiency	1- The ratio of total bank expenses to total bank revenues: $C = \text{Total Cost Banks} / \text{Total Revenue Bank}$ 2- Ratio of operating profit to operating costs: $D = \text{granting facilities for receiving interest} / \text{depositors to pay interest}$
Earning Quality	1- Return on Asset Ratio (ROA): $I = (\text{net profit}) / (\text{total assets})$ 2- Capital return ratio (ROE): $J = (\text{net profit}) / (\text{total capital})$
Liquidity	1- Cash balance ratio with the Central Bank and the bank account to deposits: $G = \text{Bank account and central bank with current, cash balance} / \text{Total deposit}$ 2- Deposit retention ratio: $H = ((\text{demand deposit} + \text{deposit repayment savings}) = \text{deposit capital investment}) / \text{deposit escape}$
Sensitivity to Market Risk	1- The beta ratio of the bank's shares in the Tehran Stock Exchange market 2- Sensitivity to interest rate ratio: $K = (\text{asset sensitivities}) / (\text{debt sensitivities})$

According to research conducted inside and outside Iran, CAMELS indicators are one of the most important types of analysis to evaluate the performance in the Islamic banking industry and Iranian banking. And compares important indicators in the banking sector. Therefore,

CAMELS model can be used in Iran as an efficient, effective and accurate tool to evaluate the performance in the banking industry and predict the future and related risks. The results obtained are very important for managers, because the CAMELS model can be an effective tool for management, control and decision-making from the perspective of management accounting in Iran and in the international community (Abdollahi Poor and et al., 2020). For this purpose, in this study, CAMELS indicators were implemented in accordance with the rules of Iranian banks. Accordingly, the method of calculating the ratios used in this study was done according to the rules governing Iranian banks, which are given in Table 1. Then the ranking of banks for financial performance have been done on the basis of following criteria:

Table 6  
*CAMELS Ranking Criteria*

<b>CAMELS Ranking Criteria</b>	<b>Ranking of bank health levels</b>
very strong	Ratings less than $\bar{x}-.842 \sigma$
Strong	Ranks within the range $\bar{x}-.842 \sigma$ , $\bar{x}-.253 \sigma$
Medium	Ranks within the range $\bar{x}-.253 \sigma$ , $\bar{x}+.253 \sigma$
Weak	Ranks within the range $\bar{x}+.253 \sigma$ , $\bar{x}+.842 \sigma$
Very weak	Ranks greater than $\bar{x}+.842 \sigma$

### Findings

In order to rank the studied banks with CAMELS indices, first the financial ratios of each index were calculated and based on the extent of their impact on financial distress, each of the CAMELS sub-indices was ranked. Which is described in Tables 7 to 12.

Table 7  
*Capital Adequacy Ratio Ranking*

Bank's Name	Ratio of capital to risk-weighted assets (capital adequacy)		Ratio of shareholders' equity to total assets (ownership)		Group Rank
	%	RANK	%	RANK	Mean
Mellal	.0173	16	0.038237659	13	14.5
Eghtesad novin	.0449	10	0.025867968	15	13.5
Ansar	.052	6	0.040548702	12	9
Iran zamin	.019	15	0.082053108	5	10
Parsian	.044	11	0.001384976	17	14
Pasargad	.0719	4	0.068429958	7	5.5
Tejarat	.11	3	0.084830712	4	3.5
Hekmat Iranian	.12	2	0.133698596	3	2.5
Dey	.29	1	0.299598443	2	1.5
Saman	.0378	13	0.032307201	14	13.5
Sarmaye	.058	5	1.215366344	1	3
Sina	.051	7	0.06752115	8	7.5
Saderat	.0089	17	0.063066038	9	13
Karafarin	.05	8	0.078502787	6	7
Gardesh	.043	12	0.008974566	16	6.5
Mellat	.045	9	0.051016669	11	10
Post Bank	.0225	14	0.051600789	10	12

As shown in Table 7, the various capital adequacy ratios are shown; the bank that has with the highest capital adequacy ratio is ranked first. In the meantime, "Bank Dey" is in the first place. Also, the bank that has acquired a higher ratio of equity to total assets is ranked first. Among these, "Sarmaye Bank" is in the first place. After determining the rankings of all banks, the average ratings they obtained were calculated, which is given in the sixth column.

Table 8

*Asset Auality Ratio Ranking*

Bank's Name	Debt ratio		The ratio of non-current receivables to the total facilities		Group Rank Mean
	%	RANK	%	RANK	
Mellal	1.454009124	15	0.011657615	2	8.5
Eghtesad novin	1.046904843	7	0.102965444	8	7.5
Ansar	1.149300266	11	0.435909638	15	13
Iran zamin	1.26874569	14	1.007246994	17	15.5
Parsian	1.103910875	10	0.178745109	11	10.5
Pasargad	0.960265012	5	0.03772357	4	4.5
Tejarat	0.905264649	2	0.070692294	7	4.5
Hekmat Iranian	0.895518946	1	0.319029256	14	7.5
Dey	1.600942533	16	0.144377284	9	12.5
Saman	1.156603576	12	0.057912658	6	9
Sarmaye	3.246698949	17	0.046432888	5	11
Sina	0.931864635	4	0.003011766	1	2.5
Saderat	1.078678614	9	0.145484577	10	9.5
Karafarin	0.931342406	3	0.195500077	12	7.5
Gardesh	0.997250414	6	0.025479946	3	4.5
Mellat	1/056876221	8	0/200869354	13	10.5
Post Bank	1/267184959	13	0/499724592	16	14.5

As shown in Table 8, the various asset quality ratios are shown, with the bank with the lowest debt ratio ranking first. In the meantime, Hekmat Iranian Bank is ranked first. Also, a bank that has a lower ratio of non-current receivables to total facilities is ranked first. In the meantime, "Sina Bank" is in the first place. After determining the rankings of all banks, the average ratings they obtained were calculated, which is given in the sixth column.



Table 9

*Liquidity Ratio Ranking*

Bank's Name	Cash balance ratio with the Central Bank and the bank account to deposits		Deposit retention ratio		Group Rank
	%	RANK	%	RANK	Mean
Mellal	0.009066414	16	1	1	8.5
Eghtesad novin	0.084151703	6	1	1	3.5
Ansar	0.044754239	13	1	1	7
Iran zamin	0.00243668	17	0/995550649	2	9.5
Parsian	0.093850082	4	1	1	2.5
Pasargad	0.184421642	1	1	1	1
Tejarat	0.088761157	5	1	1	3
Hekmat Iranian	0.075709872	8	1	1	4.5
Dey	0.043333103	14	1	1	7.5
Saman	0.408121029	3	1	1	2
Sarmaye	0.031138472	15	1	1	8
Sina	0.053303391	11	1	1	6
Saderat	0.061089444	10	1	1	5.5
Karafarin	0.080084091	7	1	1	4
Gardesh	0.048928365	12	1	1	6.5
Mellat	0.06746674	9	1	1	5
Post Bank	0.115370608	2	1	1	1.5

As shown in Table 9, the various liquidity coverage ratios are shown, with a bank with both a liquidity coverage ratio and a higher deposit retention ratio ranking first. After determining the rankings of all banks, the average ratings they obtained were calculated, which is given in the sixth column.

Table 10

*Management Efficiency Ratio Ranking*

Bank's Name	The ratio of total bank expenses to total bank revenues		Ratio of operating profit to operating costs		Group Rank
	%	RANK	%	RANK	Mean
Mellal	0.923523558	9	1.879983996	2	5.5
Eghtesad novin	1.311526799	13	0.88645106	11	12
Ansar	1.310526799	12	0.88745106	10	11
Iran zamin	5.503251653	17	0.13013169	17	17

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Bank's Name	The ratio of total bank expenses to total bank revenues		Ratio of operating profit to operating costs		Group Rank Mean
	%	RANK	%	RANK	
Parsian	0.889905475	8	0.773055186	12	10
Pasargad	0.642917229	2	1.279329475	4	3
Tejarat	1.14263002	11	1.128588871	7	9
Hekmat Iranian	0.665313684	4	1.189378096	1	2.5
Dey	0.726328546	5	0.341523832	15	10
Saman	0.656572533	3	0.722975143	13	8
Sarmaye	1.699327404	15	0.141556922	16	8
Sina	0.834125638	6	1.203202329	5	5.5
Saderat	1.318789792	14	1.090787362	9	11.5
Karafarin	0.869036097	7	1.110548865	8	7.5
Gardesh	1.062903788	10	0.640199908	14	12
Mellat	0.432801587	1	1.384842388	3	2
Post Bank	1.83366138	16	1.157498862	6	11

As shown in Table 10, the different ratios of management quality calculations are shown. The bank that has the ratio of total bank expenses to total bank revenues is ranked first. Among these, "Bank Mellat" is in the first rank. Also, the bank that has the ratio of operating profit to higher operating costs is also ranked first. Among these, "Hekmat Iranian Bank" is ranked first. After determining the rankings of all banks, the average ratings they obtained were calculated, which is given in the sixth column.

Table 11

*Earning Quality Ratio Ranking*

Bank's Name	Return on Asset Ratio (ROA)		Capital return ratio (ROE)		Group Rank Mean
	%	RANK	%	RANK	
Mellat	0.006168928	11	0/215590429	8	9.5
Eghtesad novin	0.004244508	13	0/149258168	11	12
Ansar	0.003791424	14	0/1959909	9	11.5
Iran zamin	0.066000984	3	4/98252	3	3
Parsian	0.001646256	16	0/086007534	15	15.5
Pasargad	0.016198305	7	0/380438333	7	7
Tejarat	0.002841826	15	0/024656837	17	16

## PREDICTING BANKS' FINANCIAL DISTRESS BY DATA ENVELOPMENT

Bank's Name	Return on Asset Ratio (ROA)		Capital return ratio (ROE)		Group Rank
	%	RANK	%	RANK	Mean
Hekmat Iranian	0.019922147	6	0/188151833	10	8
Dey	0.155004964	2	6/041386406	2	2
Saman	0.010682939	8	0/6429115	6	7
Sarmaye	0.516357842	1	20/050858	1	1
Sina	0.005932925	12	0/1224391	14	13
Saderat	0.009577456	9	0/137533229	13	11
Karafarin	0.006997763	10	0/145575529	12	11
Gardesh	0.000734229	17	0/045432167	16	16.5
Mellat	0.035525834	4	2/41954962	4	4
Post Bank	0.030531235	5	1/369887158	5	5

As shown in Table 11, the various profitability ratios are shown, with the bank with the highest asset returns ranking first. Among these, "Sarmaye" is in the first place. Also, the bank with the highest return on investment is ranked first. Among these, "Sarmaye Bank" is in the first place. After determining the rankings of all banks, the average ratings they obtained were calculated, which is given in the sixth column.

Table 12

*Sensitivity to Market Risk Ratio Ranking*

Bank's Name	The beta ratio		Sensitivity to interest rate ratio		Group Rank
	%	RANK	%	RANK	Mean
Mellal	0.42	13	1.346784596	1	7
Eghtesad novin	0.629888016	7	0.892891597	3	5
Ansar	0.045306058	17	0.701889842	9	13
Iran zamin	0.466049216	11	0.25406275	17	14
Parsian	0.386849848	14	0.795509476	6	10
Pasargad	0.897593592	3	0.923466074	2	2.5
Tejarat	0.473731686	10	0.590379692	10	10
Hekmat Iranian	0.234617951	16	0.540732319	11	13.5
Dey	0.642694561	6	0.464061484	15	10.5
Saman	1.565096883	1	0.515404877	12	6.5
Sarmaye	0.725986187	5	0.485296563	14	9.5
Sina	0.545932846	8	0.819271926	5	6.5
Saderat	0.424035153	12	0.737974678	7	9.5

## PREDICTING BANKS' FINANCIAL DISTRESS BY DATA ENVELOPMENT

Bank's Name	The beta ratio		Sensitivity to interest rate ratio		Group Rank
	%	RANK	%	RANK	Mean
Karafarin	0.538448241	9	0.721643212	8	8.5
Gardesh	0.860147323	4	0.450660063	16	10
Mellat	1.527594234	2	0.495677838	13	7.5
Post Bank	0.351824582	15	0.841022621	4	9.5

As can be seen from Table 12, the various ratios of market risk sensitivity calculations are shown, with the bank having the highest stock of bank shares in the Tehran Stock Exchange being ranked first. In the meantime, "Saman Bank" is in the first rank. And a bank with a higher interest rate sensitivity ratio is ranked first. Among them, the "Mellal Bank" is ranked first. After determining the rankings of all banks, the average ratings they obtained were calculated, which is given in the sixth column. After determining the rankings of all banks, the average ratings they obtained were calculated, which is given in the sixth column. After determining the ranking of each of the CAMELS indicators, based on the average of the combined ratings and the standard deviation of the sample, the overall combined rating and banking health level of each of the banks evaluated was studied. Which are described in Tables 13 and 14.

Table 13

*General Combined Ranking Evaluated*

Bank's Name	Capital Adequacy	Asset Quality	Liquidity Coverage	Management Quality	Earning Ratio	Sensitivity to Market risk	Average Combined Ratings	Final Rank
Mellal	14.5	8.5	8.5	5.5	9.5	7	8.91	11
Eghtesad novin	13.5	7.5	3.5	12	12	5	8.91	10
Ansar	9	13	7	11	11.5	13	10.75	16
Iran zamin	10	15.5	9.5	17	3	14	11.5	17
Parsian	14	10.5	2.5	10	15.5	10	10.41	15
Pasargad	5.5	4.5	1	3	7	2.5	3.91	1
Tejarat	3.5	4.5	3	9	16	10	7.66	8
Hekmat Iranian	2.5	7.5	4.5	2.5	8	13.5	6.41	2

## PREDICTING BANKS' FINANCIAL DISTRESS BY DATA ENVELOPMENT

Bank's Name	Capital Adequacy	Asset Quality	Liquidity Coverage	Mangement Quality	Earning Ratio	Sensitivity to Market risk	Average Combined Ratings	Final Rank
Dey	1.5	12.5	7.5	10	2	10.5	7.33	6
Saman	13.5	9	2	8	7	6.5	7.66	9
Sarmaye	3	11	8	8	1	9.5	6.75	4
Sina	7.5	2.5	6	5.5	13	6.5	6.83	5
Saderat	13	9.5	5.5	11.5	11	9.5	10	14
Karafarin	7	7.5	4	7.5	11	8.5	7.58	7
Gardesh	6.5	4.5	6.5	12	16.5	10	9.33	13
Mellat	10	10.5	5	2	4	7.5	6.5	3
Post Bank	12	14.5	1.5	11	5	9.5	8.91	12

According to the data in Table 3, the total average of the composite rankings is approximately equal to 8.20 and the standard deviation of the sample of the average composite rankings is equal to 1.91. Therefore, after determining the mean and standard deviation of the sample, the levels are determined as in Table 2, which is described in Table 14.

Table 14

*Leveling the Performance of Banks*

CAMELS Ranking criteria	Bank name	Ranking of bank health levels
Ratings less than 6.59	Pasargad,hekmat,Mellat	too strong
Ranks within the range of 6.59 to 7.69	Tejarat, Dey ,Sarmaye, Sina, Karafarin ,Saman	Strong
Ranks within the range of 7.69 to 8.71	....	Medium
Ranks within the range of 8.71 to 9.88	Mellal ,Eghtesadnovin, Gardeshgary, Post Bank	Weak
Ratings higher than 9/88	Ansar, Iran Zamin, Parsian, Saderat	Too Weak

After determining the health range of each bank, the performance of the data envelopment analysis model was evaluated and the financial distress of the mentioned banks was predicted. According to Table 13, the study sample has 9 healthy banks and 8 financially distressed banks.

## PREDICTING BANKS' FINANCIAL DISTRESS BY DATA ENVELOPMENT

The results of forecasting the financial distress of the studied banks with the Data Envelopment Analysis show that out of 17 banks surveyed, 13 banks They have the efficiency of one, or in other words, they are on the verge of financial helplessness. Other information is given in Table 15.

Table 15.

*Prediction of Financial Distress*

Healthy Banks			Distressed Bank		
Efficiency	Bank	No.	Efficiency	Bank	No.
.5691	Pasargad	1	1	Mellal	1
1	Hekmat	2	.6862	EN Bank	2
.1303	Mellat	3	1	Gardeshgary	3
1	Tejarat	4	1	Post Bank	4
1	Day	5	1	Ansar	5
1	Sarmaye	6	1	IranZamin	6
1	Sina	7	1	Parsian	7
.1982	Karafarin	8	1	Saderat	8
1	Saman	9			

After calculating the efficiency, the values A, B, C and D, which are related to the four groups mentioned in the financial distress border in the previous section, were calculated according to Table 16.

Table 16

*Frequency and Percentage of Healthy and Distressed Financial*

	Banks that are on the frontiers of financial distress		Banks that are not on the frontiers of financial distress		Sum of Banks
	Frequency	Percent	Frequency	percent	
Distressed Bank	7	88	1	12	8
Healthy Bank	6	66	3	34	9
Sum of Banks	13	13	4	4	17

In the next step, the number of banks belonging to these four groups was determined, then according to Table 8, the ratios of critical and non-



critical probabilities were calculated. And the first type error and the second type error were identified. This information is given in Table 17.

Table 17

*First Type Error and Second Type Error*

Rows	Ratio	Amount(percentage)
1	P (BR/BR)	88
2	P (NBR/BR)	12
3	P (NBR/NBR)	34
4	P (BR/NBR)	66

According to Table 16, rows one and three show the correct classification, and row two indicates the first type of error and row four indicates the second type of error. These two types of errors are equal to 12% and 66%, respectively. Which indicates a wrong prediction. In general, it can be said that 61% of the predictions by the data envelopment analysis technique were correct and 39% of them were incorrect. This information is given in Table 18.

Table 18

*Evaluation of Predicted Accuracy*

Observed	DEA		Correct Percentage
	.00	.1	
Financial Distress .00	7	1	88
Healthy .1	6	3	34
Total Percentage	13	4	61

The results of this study emphasize the need to predict financial distress, which in this regard is consistent with the results of Alfiyanti et al (2020), Chairunesia and Bintara (2019) and Ahmadyan and Gorji (2017). The results of this study also confirm the need to pay attention to the international indicators of CAMELS. These findings are similar to the results of Abdollahi Poor et al(2020), Ahmadyan(2017 and 2018), Soudani (2017), Ramezani et al(2017), Masood et al(2016), Kamrul (2016), Ahsan (2016) , Trivedi and Elahi (2015), Roman and Sarjo

(2013). Also, the results of this study showed that it is possible to develop a financial health model based on CAMELS indicators in Iranian banks. These findings are consistent with the results of Abdollahi Poor et al (2020), Soleimani et al (2020), Soudani (2017), Ahmadian (2017 and 2018), Ramezani et al (2017), Khanifar et al (2015). Therefore, due to the effectiveness of the activities of financial institutions in society, due to the bank-oriented nature of the country's economy and the inability of the public to identify and distinguish the health of banks from each other, the existence of a model and ranking system can help stakeholders identify high-risk banks. It has increased the transparency of banks' performance and also guided applicants in purchasing banking services and products. It has also encouraged bank managers to systematically improve their behavior and performance without pressure from regulators. And in order to maintain and improve their position, always seek to improve and modify the desired indicators and criteria and act voluntarily according to market demands. Also, the Central Bank, in addition to implementing the rules and guidelines of the Basel Committee on Banking Supervision in the form of CAMELS indicators and ranking banks based on them, will be able to increase the level of transparency and soundness of the banking system. And in the international dimension, banks will be able to meet the desired value of these indicators, start their opening operations with reputable international banks and increase profitability and increase the value of their shares.

### Conclusion

Predicting the financial distress of banks is one of the fundamental issues in the field of economics and finance and makes timely decisions and appropriate adjustments in the allocation of resources. Very satisfactory results can be achieved by predicting financial distress and then finding the root of the problem and solving it. Predicting the financial distress of banks is also very important for investors, creditors, managers, auditors, the government and especially the central bank.

Therefore, the development of statistical models to predict health as well as the risk of bankruptcy of banks is very necessary. In this regard, the purpose of this research is to test the ability of CAMELS indices in order to provide a model for evaluating and predicting the health of banks listed on the Tehran Stock Exchange. To cover the characteristics of 6 CAMELS indices, 12 selected financial ratios were introduced. Then, CAMELS indices were used to assess the risk of financial distress of banks and to separate healthy and helpless banks evaluated by the research. And it turned out that in terms of capital adequacy index, "Sarmaye Bank" and "Bank Dey" are in the first place. Also, in terms of asset quality index, "Hekmat Iranian Bank" and "Sina Bank" are in the first place. In terms of liquidity index, all banks except "Iran Zamin Bank" are in the first place. In terms of management quality index, "Bank Mellat" and "Bank Hekmat Iranian" are in the first place. In terms of earning index, "Sarmayeh Bank" is in the first place. In terms of market risk sensitivity index, "Saman Bank" and "Bank Mellat" are in the first place. Also, in this study, the health level of each bank was determined by CAMELS indicators. That the banks of Pasargad, Hekmat Iranian, Mellat were in a very strong range. Also, Tejarat, DEY, Sarmayeh, Sina, KarAfarin and Saman banks were in a strong range. Mellat, Eghtesad novin, Gardeshgari and Post Bank were also in a weak range, while Ansar, Iran Zamin, Parsian and Saderat Iran were in a very weak range. From the study it is suggested that the worst performing banks have to improve their position in terms of Capital adequacy, asset quality, management efficiency, Earning, liquidity and sensitivity to come at par with banks having good financial performance. so Pasargad, Hekmat Iranian, Mellat, Tejarat, Dey, Sarmayeh, Sina, Karafarin, Saman as healthy banks and banks; Credit of Nations, New Economy, Tourism, Post Bank, Ansar, Iran Zamin, Parsian, Saderat Iran were identified as financially helpless banks and also in order to predict the financial distress of banks from SBM non-radial data envelopment analysis model with a different approach It was discussed that the path of research

analysis was changed based on the border of financial helplessness of banks instead of the border of efficiency of banks and the results showed that out of 17 banks surveyed, 13 banks are ranked first and this means Catching these banks is on the verge of financial helplessness, and then the critical and non-critical probabilities were calculated and it was found that the accuracy of the prediction of financially helpless banks 88 Percentage and accuracy of healthy banks forecast 34 Percent and also generally 61 Percentage of predictions by data envelopment analysis technique is correct and 39 percentage of them, was wrong. Also, the results of this study showed that CAMELS financial ratios can be a good assessor for banks' financial distress. Therefore, banks and credit institutions can use the financial ratios used in this research in the ranking process of their sub-categories. In general, it can be said that by using the results of this research as a first step, it is possible to prevent banks from suffering from financial helplessness and eventually bankruptcy, as well as its consequences. Of course, if after forecasting, the root of the problem is addressed and its causes are traced.

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