



## **Using Decision Tree Technique to Predict the Financial Collapse of Iraqi Private Banks: An Applied Study**

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**Abstract.** Predicting the Financial Collapse (FC) using modern technologies and scientific methods for Iraqi private banks is considered an early warning to detect their failure in the future. Therefore, these proposals, represented by scientific methods and modern technologies, are submitted to the specialized bodies represented by (the Central Bank of Iraq) in order to present them to the banks in the research sample to raise their capacity through the use of modern technologies and in order to adopt them as a scientific basis for predicting the FC. The following will be followed: Evaluating the performance of banks and classifying them based on the Camels standard (CS) and predicting the FC based on modern technologies (by relying on the decision tree algorithm). The research relied on the deductive approach to complete the theoretical aspect and the applied (experimental) approach to complete the practical aspect. The researcher also processed and prepared the data and then evaluated the performance of banks and classified them based on the CS equations consisting of five indicators and on the averages of these results as inputs for prediction using DT. Different computer programs were also adopted, as the Excel program was used to unload the data, the (SPSS) program to apply the equations, and the (Matlab) program to predict modern technologies. The most prominent conclusions reached by the research are as follows: Modern technologies represented by decision trees are characterized by providing more accurate information that helps judge the extent of banks' continuity in practicing their activity and avoiding FC.

**Keywords.** Financial collapse; decision trees; Camels standard

### **INTRODUCTION:**

The banking sector (including private banks) is one of the critical economic sectors that work to attract more investments and contribute to diversifying economic resources in a way that contributes to achieving sustainable development. However, the circumstances that these banks have witnessed, whether political, security, or economic, have negatively affected their activity, and some of them have been exposed to bankruptcy for several reasons, perhaps the most important of which is the weak reliance of these banks on scientific methods in evaluation and prediction. This requires them to adopt modern methods and techniques that help them evaluate, predict, and make the appropriate decision at the appropriate time to prevent bankruptcy and



their inability to continue their activity. Therefore, this research provided a scientific contribution that helps banks adopt modern methods and techniques in performance evaluation and FC prediction. The studies that dealt with the research: (Al-Khayat study, 2012) (Using the Sherrord model to predict bank failure - an applied study of a sample of private banks in Nineveh Governorate for the period (2007-2009): The study aimed to use the Sherrord model to predict the financial failure of private banks in Nineveh Governorate by determining the extent of success and failure of these banks in continuing and surviving and the extent of exposure of their loans to default and its adverse effects on the national economy. The study relied on one of the traditional models, the Sherrord model, and the most important conclusions reached by the study. Banks adopting the Sherrord model have to predict financial failure and to know the extent of the ability of the companies that will lend to them to be able to continue or not. The study of Ismail et al., 2013 (Predicting the financial failure of companies using artificial intelligence - an applied study in the Iraqi Stock Exchange) The study aimed to present and analyze the importance of artificial intelligence and its role in prediction and clarify the concept of neural networks as one of the modern means and techniques used in intelligence Artificial intelligence, and determining the financial indicators that reflect the company's ability to continue its activity by identifying companies that will suffer financial failure using innovative neural network technology. The study relied on modern techniques represented by neural networks, which are implemented using the (Matlab) program, and traditional methods represented by financial ratios (profitability, return on activity). One of the most important conclusions reached by the study is the possibility of predicting the financial failure of economic units through three financial ratios using neural networks. As indicated by the study by Qaiser & and others, 2011. (Predicting Bankruptcy in Pakistan) which aimed to reach a model that can predict the financial bankruptcy affecting Pakistan's banks. The most important conclusions were obtaining a model capable of predicting the financial bankruptcy of banks with an accuracy of (80%) only two years before the bankruptcy occurs and reaching three crucial financial ratios. The economic unit must provide an early warning system for the danger that may threaten it to avoid it promptly. This is done by evaluating its performance and predicting what it will be like in the future, using advanced scientific methods and modern technologies. One of these technologies is the decision tree technology. DT are considered a tool or means used to support decisions, as they provide a logical series of suggestions in the form of a logical syllogism, because (DT) work in the form of a conversation because the nature of their format is based on integrating and involving users in an interactive exchange that directs the user towards a conclusion based on the responses provided (Tarvin, 2015: 2) and that these DT can be displayed and explained in the form of drawings or charts to facilitate the process of translating them instead of making them a translation in the form of numbers, meaning that explaining (DT) in the form of charts and drawings contributes significantly to solving complex problems related to the decision-making process (Rakach & Maimon, 2014: 12).

## **RESEARCH METHODOLOGY**

### **1- Research problem:**

The research problem is represented by the weakness and absence of modern technologies and scientific methods to predict the risks of FC and its impact on the continuity of its activity in the future, in addition to the fact that some Iraqi banks use traditional methods and that these traditional methods used to predict FC through financial analysis based on financial ratios give inaccurate results that cannot be relied upon in judging the continuity of banks' activity,



especially with the increase in the number of banks that have been exposed to collapse and their inability to continue. The research problem can be defined by the following question:

(Does using scientific methods and modern technologies by banks (research sample) enable them to predict the FC of private Iraqi banks effectively).

## **2- Research objectives:**

The general objective of the research is to predict financial failure using modern technologies and scientific methods for Iraqi private banks in order to provide an early warning system for their future collapse and then submit these proposals represented by scientific methods and modern technologies to the specialized authorities represented by (the Central Bank of Iraq) in order to submit them to the banks of the research sample to raise their capacity through the use of modern technologies and in order to be adopted as a scientific basis for predicting FC. The following secondary objectives will be followed to clarify this general objective:

- 1- Evaluating the banks of the research sample and classifying them using the CS.
- 2- Predicting the FC of the research sample banks by adopting modern technologies through the application of DT technology.

## **3- The importance of the research:**

The importance of the research stems from the importance of using modern technologies and their ability to raise the level of efficiency of Iraqi private banks in the field of predicting FC, especially with the challenges facing private banks represented by their inability to meet their obligations and the exposure of some of them to bankruptcy and liquidation, so adopting modern technologies such as DT technology, which helps in predicting FC and indicating the ability of banks to continue their activity is a necessary and urgent requirement at present.

## **4- Research hypotheses:**

The research is based on a hypothesis that states:

(There is an effect between the use of decision tree technology and the ability of the research sample banks to predict FC and judge the continuity of Iraqi private banks).

## **5- Data collection methods:**

The researchers relied on the following sources to collect and analyze the data and information needed for the research:

To complete the theoretical aspect: The researchers relied on Arabic and foreign books, letters, theses, periodicals, and the Internet.

To complete the practical aspect: The researchers relied on the following:

A- Financial reports issued by the banks in the research sample, B- Personal interviews where the opinions of a group of specialists were used regarding the comparison criteria that were not agreed upon by the Central Bank of Iraq and were not specified internationally

## **6- Statistical methods and programs used in the research:**

- 1- Using the (Microsoft Excel\*) program to unload the data that will be relied upon in the evaluation process according to the (CAMELS) standard.
- 2- Using the (SPSS\*) program to carry out the initial processing of the (CAMELS) standard consisting of (five) indicators.
- 3- Using the (Matlab\*) program to predict the FC using the DT algorithm.

## **7- Research Approach:**

The deductive approach will be adopted in completing the theoretical aspect and the applied (experimental) approach in completing the practical aspect, where the following steps were adopted:

- 1- Data collection.
- 2- Data extraction representing the variables of financial indicators.

3- Preprocessing, where the (CAMELS) (\*) standard consisting of (five) indicators will be applied in order to evaluate the performance of banks, in addition to classifying them into (strong, satisfactory, good, marginal, unsatisfactory), and this is considered an early warning that will help in discovering the financial imbalance (if any) in the performance of banks.

4- Predicting the FC of the banks in the research sample by adopting modern techniques represented by DT

5- Formulating proposals and recommendations for the concerned parties and decision-makers.

### **8- Research community and sample:**

The research community is represented by the private trade banks listed in the Iraq Stock Exchange, which number (33) banks. In contrast, the research sample was represented by (2)\* banks (the Trade Bank of Iraq and the Union Bank of Iraq).

\* Microsoft Excel: A statistical program included in the SPSS program packages used to unpack data.

\* SPSS is an English computer program with comprehensive computational packages and data. It is considered one of the most widely used programs for analyzing statistical information.

\* Matlab: A programming language in engineering, mathematical applications, and algorithm implementation.

\* The market risk sensitivity index (S) will be excluded because the Central Bank of Iraq does not apply it.

\*The researcher relied on this sample of banks due to the completeness of its data.

### **9- Research limits:**

1- Spatial limits: The spatial limits of the research are represented by the private Trade Banks listed in the Iraq Stock Exchange.

2- Temporal limits: This research will rely on the published financial data of the Iraqi private Trade Banks listed in the Iraq Stock Exchange for the years (2006-2015) which amount to (10 years).

## **THE THEORETICAL FREAMWORK**

### **The concept of decision trees:**

Decision trees are a hierarchical tree-like shape in which each sub-node represents a choice between a few alternatives and each leaf node represents a decision (Maseer & Flayyih, 2021). These DT are used to obtain information to benefit from it. This tree starts from the root that is used to act. From this root, decision-makers divide each node repeatedly according to the network training algorithm. The result is the decision tree, in which each branch represents a possible scenario for the decision and its results (Flayyih & Khiari, 2023). These DT are also one of the most widely used modern algorithms in data analysis because they are beyond doubt and easy to visualize and comprehend (Kilan, 2013: 43). There are also several different concepts of DT, including (M. Hamlich & others, 2018: 3). It is a method of supervision and learning that is done by using input data that is relied upon in building the tree in order to obtain outputs from the nature of the decisions in the tree that represent the final decision. The types of nodes that make up DT (Kaminski, 2017: 220). Decision trees consist of three types of nodes:

1- Decision node: It is usually represented in squares.

2- Knots of opportunity (probability): represented by circles.

3- The final node: represented by squares.

It can be noted that - the advantages of DT: are represented by the following:

(Quanu&other,2018:1; Al-Saudi & Flayyih, 2024) stated that DT are characterized by several advantages, including:

1- It is an effective algorithm that can deal with missing data.

2- Unlike classical statistical methods, the decision tree algorithm does not require the distribution of assumptions.

3- Ease of understanding and interpretation.

- 4- It has value even with little data.
- 5- It allows the addition of new scenarios and events.
- 6- The ability to process non-numerical data excellently.

From what was mentioned above, researchers see that DT are advanced technologies that work in an easy, simple, and understandable way for users, in addition to their extraordinary ability to Solve complex problems scientifically and quickly by relying on groups of decisions that are pyramidal starting from the root until reaching the final decision that will be taken from among a group of available decisions (alternatives). It can also be noted that FC represents a situation facing most economic units due to the environment surrounding these units and the high risk they enjoy, which negatively affects them and increases the possibility of their exposure to collapse because the collapse of economic units is preceded by several stages or cases that the economic unit goes through in order to reach a state of financial failure, as this failure is represented by the inability of the economic unit to pay its obligations on time, in addition to its expansion by borrowing, which results in significant losses borne by the economic unit and thus exposes it to bankruptcy and liquidation (Saleh and Ahmed, 2016: 202). Therefore, FC is a state of imbalance facing the economic unit due to its inability to pay its short-term obligations on time, in addition to the weakness of the resources and capabilities available to it, whether internal or external. This state of imbalance may vary between temporary or permanent balance. The more structural the imbalance is, the more difficult it is for the economic unit to overcome this state of instability and imbalance (Shetty, 2012: 88). According to the opinion of (Al-Mashhadani and Al-Shadhar), it is the inability of the economic unit to sell its products and services well in order to obtain an appropriate return, in addition to its inability to fulfill its commitments and obligations on time (Al-Mashhadani and Al-Shadhar, 2014: 505).

Researchers believe that financial distress, hardship, bankruptcy, and failure are different terms and are not similar (synonymous), meaning that one differs from the other. However, they represent the inability of the economic unit to pay its short-term obligations on their due date because each term has its stage. The financial failure of the economic unit goes through several stages, the first of which is financial distress, which results from the accumulated losses of the unit. If the management of the economic unit can address the problem of financial distress, the unit does not move to the stage of financial distress. Thus, the economic unit must reach the financial failure and bankruptcy stage. In other words, the financial failure of the economic unit does not occur if the management can address the risk in the stage of distress or hardship that precedes the stage of financial failure. The opinions of researchers differed in determining the types of financial failure, but most researchers agreed on these types.

1- Business failure: The failure occurs through a set of financial problems and obstacles that the economic unit suffers from, which may lead it to end its work and its relationship with loss, i.e. (liquidation). This type of failure is sometimes determined by the financial analysis unit (Dun & Bradstreet)\* (Thamer, 2018: 30).

2- Economic failure: This type of failure is determined when the economic unit cannot cover the costs incurred, including financing capital (Al-Rikabi and Al-Kaabi, 2013: 117).

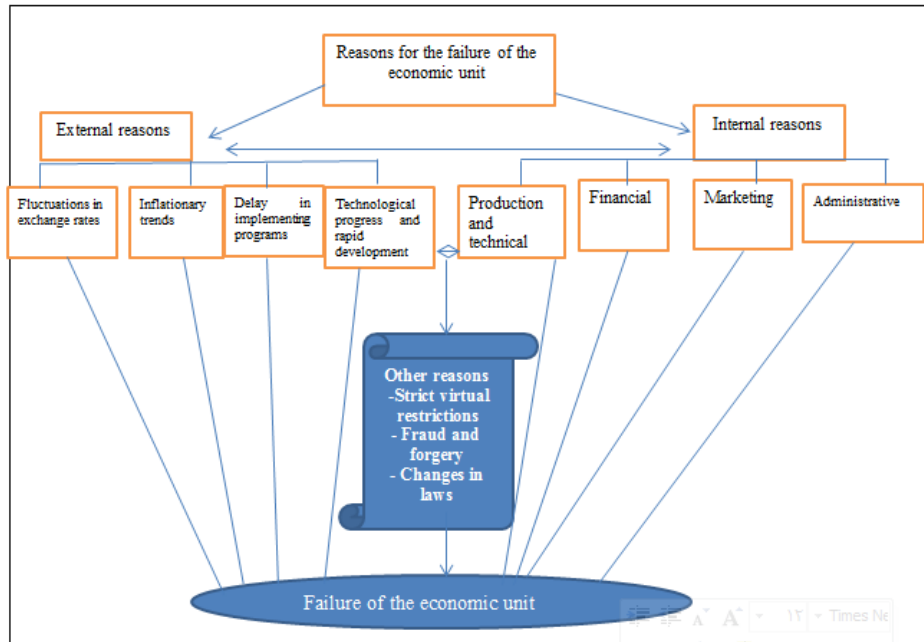
3- Administrative failure: This type of failure is represented by the weakness of the capacity and efficiency of the administrative system of the economic unit, which leads to the inability to control the results of its work, which leads to negative results that make it unable to determine and estimate what will happen to it in the future, in addition to the deterioration in profits, and thus it is unable to modify its plans or adapt to its external environment (Ammar, 2011, 115).

The reasons for the collapse of economic units are represented as follows:



\* Dun & Bradstreet: A firm specializing in financial analysis and performance evaluation.

**Figure (1) Reasons for the failure of the economic unit**



**Source: Conducted by researchers**

Based on what was mentioned above, the stages of FC are as follows: 1- The stage of feeling the emergence of the problem (the emergence of the symptom). 2- Liquidity deficit stage, 3- Financial insolvency stage, 4- Total insolvency stage, 5- Liquidation stage (bankruptcy): Through what was mentioned about the FC in terms of manifestations, causes, and stages, the economic unit must provide an early warning system about the danger that may threaten it in order to avoid it promptly. This is done by evaluating its performance and predicting what it will be like in the future by evaluating the performance of banks using the CS and then predicting the FC using the decision tree technique. Therefore, the CS is considered a modern and organized evaluation standard that comprehensively evaluates banks (quantitative and qualitative aspects). This standard is also one of the essential means used and relied upon to protect banks from failure. It represents an early warning system about the danger facing banks through six financial indicators through which the performance of banks can be evaluated, and the result of their work can be known. These indicators are capital adequacy, asset quality, management, and profitability. (Eaening, Liquidity, and market risk sensitivity (Sensitivity), (Tari'a, 2015: 23). This criterion is one of the most important criteria used in classification by regulatory bodies and institutions to assess the safety of the banking system in the world (Al-Qaisi, 2017: 465). Al-Tari'a indicated that the CAMELS criterion is an effective and meaningful method in evaluating the performance of banks by knowing the extent of their ability to adapt and deal with the changes and advanced developments associated with them and determining the strength and durability of their financial position by knowing their strengths and weaknesses, in addition to knowing the role of management and the extent of its contribution to supporting the bank (Tari'a, 2015: 3). Table (1) shows the CAMELS criterion equations:



**Table (1) CAMELS criterion equations**

No.	Index Name/Abbreviation	Legal Form
1	Capital Adequacy Ratio (C)	= Total nominal or paid-up capital + reserves + retained earnings / Total assets X 100%
2	Asset Quality Ratio (A)*	Rating ratio = Provision for doubtful debts / Total loans X 100% Total rating ratio = Bad debts / Shareholders' equity + Provision for doubtful debts X 100% The ratio of bad debts to total assets = Bad debts / Total assets X 100%
3	Management Ratio (M)	Profit growth ratio = Current net profit - Previous net profit / Previous net profit X 100%
4	Profitability Ratio (E)	Return (profit) on total assets = Net profit / Total assets X 100% Return on Equity = Net profit / Total equity X 100%
5	Liquidity Ratio (L)	Legal liquidity ratio = Liquid assets / Total deposits X 100% Cash balance ratio = Cash on hand / Total deposits X 100%
6	Market Risk Sensitivity Ratio (S)	This indicator is not applied by the Central Bank of Iraq

Source: Conducted by researchers based on reports from the Central Bank of Iraq.

**Table (2) summarizes the comparison criteria adopted in classifying banks according to the CS.**

No.	Indicator name	Approved evaluation criterion			
1	Capital Adequacy Ratio	12%			
2	Classification Percentage	Classification Degree	Classification Type	Classification Percentage	Total Classification Percentage
		1	Strong	Less than 5%	Less than 20%
	Total Classification Percentage	2	Satisfactory	5% - 15%	20% - 50%
		3	Good	15% - 35%	50% - 80%
		4	Moderately	35% - 60%	80% - 100%



		5	Unsatisfactory	60% or more	100% or more
	Non-performing loans to total assets ratio	10%			
3	Management Index*	Classification Degree	Classification Type	Evaluation	
		1	Strong	More than 30%	
		2	Satisfactory	25% - 30%	
		3	Good	20% - 25%	
		4	Moderately	15% - 20%	
		5	Unsatisfactory	10% - 15%	
4	Return on Total Assets	2.5%			
	Return on Equity*	38%			
5	Legal Liquidity Ratio	15%			
	Cash Balance Ratio	15%			

**Source: Conducted by researchers based on reports from the Central Bank of Iraq.**

Based on what was mentioned above, researchers believe that the CS gives a comprehensive and realistic view of the reality of the bank's financial system.

After completing the theoretical aspect, the researchers will explain the importance of evaluating and predicting the performance of banks using decision tree technology in the practical aspect, given the ability of these trees (DT) to solve complex problems, as we mentioned, especially problems related to the decision-making process (prediction). Researchers will use them to benefit from them in predicting the FC of Iraqi private banks.

**Third axis: Practical aspect**

The previous axis dealt with the theoretical framework of the research topic. As for this axis, in order to evaluate the performance of banks and classify them, the researchers relied on the results of the CS approved by the Central Bank of Iraq, where its equations were applied to the data of the research sample banks as a preliminary stage to predict the FC of these banks and judge their continuity. After that, the researchers predicted the FC using modern methods represented by the DT technology to reach the best method for predicting the FC.

To achieve the desired goal of this axis, the researchers divided it into three parts as shown below:





**Part One: Definition of the research sample**

**Part Two: Evaluation of the performance of the research sample banks and their classification based on the CS.**

Part Three: Modern techniques for predicting the FC of the research sample banks.

**First: Part One: Definition of the research sample.**

**Table (3)**

No.	Statement	details
<b>Trade Bank of Iraq</b>		
1	Bank Name	Trade Bank of Iraq (Private Shareholding).
	Short Code	BCOI Private
	Date of Establishment	11/2/1992.
	First Capital	150,000,000 (One Hundred and Fifty Million Dinars).
	Bank Activity	Practicing banking business.
	Bank Objectives	1-Contributing positively and clearly to the economic and social development in Iraq. 2- Developing the bank's reputation as a leading Iraqi bank and provider of financial services.
	Capital Developments	From (150) million dinars to (250) billion dinars in 2015.
	Number of Branches	10
<b>Union Bank of Iraq</b>		
2	Bank Name	Union Bank of Iraq (Private Shareholding).
	Short Code	BUOI Union.
	Date of Establishment	9/23/2002.
	First Capital	2000000000(2 billion dinars).
	Bank Activity	Practicing all banking activities.
	Bank Objectives	1- 1-Achieving the highest profitability for shareholders.

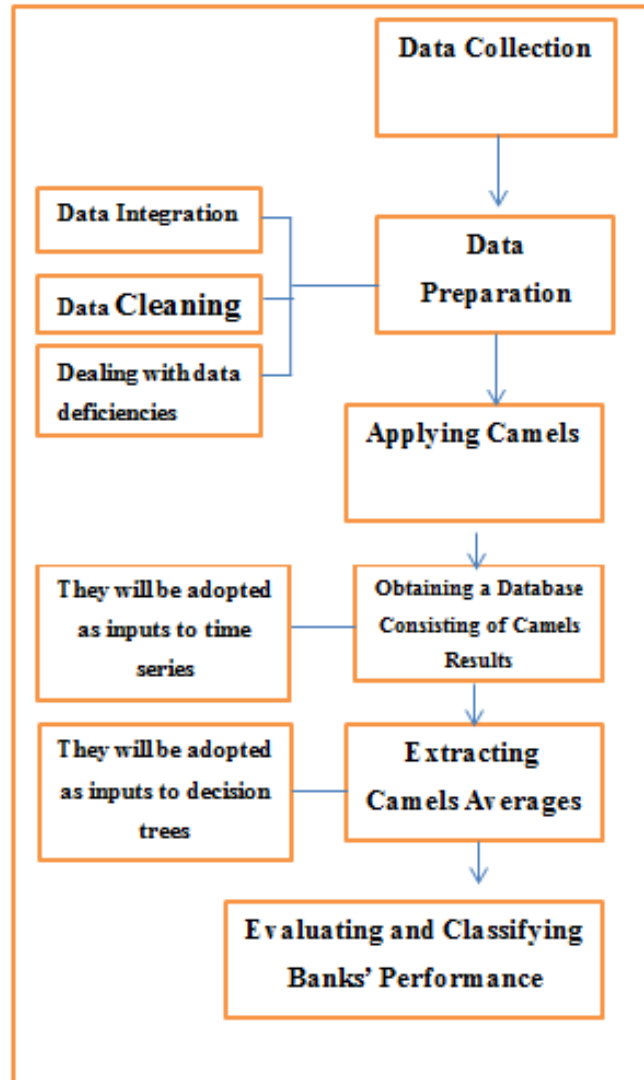


		2- Mobilizing national savings and managing them well in various investment activities and contributing to improving the country's development process
	Capital Developments	From (2) billion dinars to (252) billion dinars in 2015.
	Number of Branches	8

**Part Two: Evaluating the performance of the research sample banks and classifying them using the CS.**

In the beginning, to predict the status of the research sample banks, this section will evaluate their performance and classify them using the CS, according to the steps shown in Figure (10)

**Figure (2) Work steps for the Camel standard**



**Source: Conducted by the researchers**

After applying the equations of the CS with its five indicators that were explained in the theoretical aspect, a database was obtained containing the results of the CS for ten years for each indicator, as shown in Table (4).

Table (4) shows the results of the CS indicators for ten years for a sample of banks represented by (the Trade Bank of Iraq).



**Table (4) A sample of the results of the Camel's standard indicators for ten years (the Trade Bank of Iraq)**

Year	Capital Adequacy Ratio	Rating Ratio	Total Rating Ratio	Non-Performing Debt to Total Assets	Management Index (Earnings Growth Rate)	Return on Total Assets	Return on Equity Rate	Legal Liquidity Ratio	Cash Balance Ratio
1-	39	42	8	4	27	0	3	514	64
2-	31	100	9	4	15	0	4	49	3
3-	33	153	10	4	77	0	6	6	1
4-	42	205	12	6	-1	0	5	30	5
5-	52	2333	13	7	225	0	15	84	12
6-	57	1029	8	5	-43	0	6	143	9
7-	52	397	10	5	79	0	10	134	8
8-	61	231	8	5	-25	0	5	219	6
9-	65	139	6	4	-2	0	4	117	7
10-	68	116	7	5	-22	0	3	172	4

**Source: Conducted by researchers using the SPSS program.**

**(\*)Note that all numbers are percentages.**

After obtaining the results of this criterion for ten years, the researchers extracted the averages of the results of the criterion indicators during this stage in order to obtain a database through which they could evaluate the performance of banks and classify them. Note that these results will be adopted as inputs for prediction using DT. Table (5) shows the database represented by the average results of the Camels criterion.

**Table (5) CS Average Results**

No.	Bank's name	Nominal Capital Index	Rating Ratio	Total Rating Ratio	Non-Performing Debt to Total Assets	Earnings Growth Rate	Return on Total Assets	Return on Equity Rate	Legal Liquidity Ratio	Cash Balance Ratio
1-	Trade Bank	50	475	9	5	33	0	6	147	12



	of Iraq									
2-	Unio n Bank	56	5	3	1	158	0	10	356	9

**Source: Conducted by researchers based on the SPSS program.**

(\*Note that all numbers are percentages, the results that will be adopted as input for DT. At this stage, researchers will evaluate the performance of banks and classify them based on the results of Table (5). The classification of banks will be as follows (strong - satisfactory - good - marginal - unsatisfactory). The researcher conducted the classification process based on specific comparison criteria approved by the Central Bank of Iraq. Banks were classified according to what is mentioned in Table (5). The following Table shows:

**Table (6) Results of classifying banks according to the CS**

N o .	Ban k's na me	Nomina l Capital Index	Rating Ratio					Non- Perform ing Debt to Total Assets	Earni ngs Grow th Rate	Return on Total Assets	Return on Equity Rate	Legal Liquidit y Ratio	Cash Balan ce Ratio	Fin al Ver dict					
			1	2	3	4	5												
	Trade Bank of Iraq	50	475	9	5	33	0	6	147	12			Goo d						
		strong	unsati sfactor y	5	stro ng	1	stro ng	1	st ro n g	1	unsati sfactor y	5		unsati sfactor y	5	stro ng	1	unsati sfactor y	5
	Union Bank	56	5	3	1	158	0	10	356	9			sati sfac tory						
		strong	1	satisfa ctory	2	stro ng	1	stro ng	1	st ro n g	1	unsati sfactor y		5	unsati sfactor y	5	stro ng	1	unsati sfactor y

**Source: Conducted by researchers.**

\* Banks were classified based on (1 strong, 2 satisfactory, 3 good, 4 moderate, 5 unsatisfactory).  
 \* The zeros in the return on total assets indicator mean that the bank made a profit, but the numbers after the decimal point are minimal and have no value, so the researchers ignored them.  
 \* The final judgment process on banks was as follows: An example of this is (the Trade Bank of Iraq) since the Trade Bank of Iraq obtained a rating of (1) for the capital adequacy index, a rating of (5) for the rating ratio, a rating of (1) for the total rating ratio, a rating of (1) for the

ratio of bad debts to total assets, a rating of (1) for the profit growth rate (management indicator), a rating of (5) for the rate of return on total assets, a rating of (5) for the rate of return on Equity, a rating of (1) for the legal liquidity ratio, and a rating of (5) for the cash balance ratio, and thus  $(1 + 5 + 1 + 1 + 1 + 5 + 5 + 1 + 5 = 25)$ , and then the arithmetic mean of these numbers is extracted, so  $(25 / 9)$  (number of indicators) = 2.777, then this result is rounded to (3) and thus the bank obtains a rating of (good).

Below is an analysis of the ratios, for example, capital adequacy in the Trade Bank of Iraq and the Union Bank of Iraq.

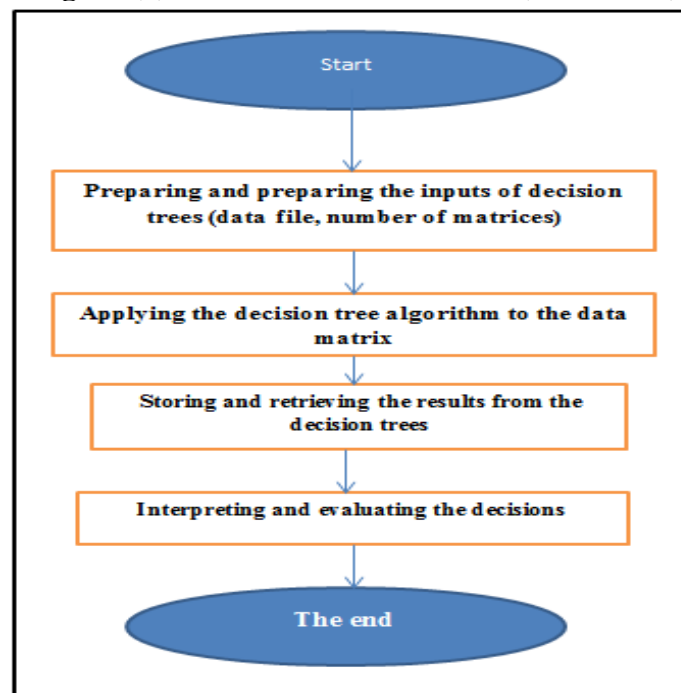
1- The Trade Bank of Iraq: The result of the capital adequacy index for the Trade Bank of Iraq was (50%) as shown in Figure (12). It is higher than the comparison standard adopted by the Central Bank of Iraq (12%), so the bank obtained a strong rating, as shown in Table (5).

2- Union Bank of Iraq: The result of the capital adequacy index for the Union Bank of Iraq was (56%) as shown in Figure (12). It is higher than the percentage adopted by the Central Bank of Iraq (12%), so the bank obtained a strong rating, as shown in Table (5). Then, the same analysis will be done for the rest of the banks.

Part Three: Modern Techniques for Predicting Financial Failure (Decision Tree Algorithm).

In this part, the researchers will explain the modern techniques for predicting collapse as shown in Figure (5), where this figure shows the work steps for DT as follows:

**Figure (3) Decision Tree Workflow (Flowchart)**



**Source: Conducted by the researchers**

After the data has been prepared to be ready for use in the decision tree technology, represented by the Camels criterion averages that were explained in the previous section, we will, at this stage, store these averages in an independent file, where each bank in the research sample contains nine values, one value for each indicator, as shown in interface (1) of the program, as follows:





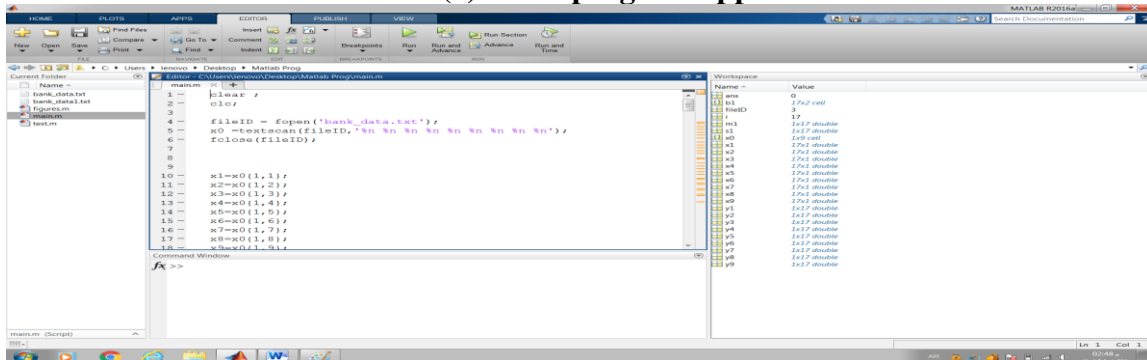
**Interface (1) Independent file for storing averages (inputs to DT in the program)**

1	100.0	175.0	5	33	0	6	107	12	
2	50.0	4	27	125.0	0	5	21.999	37465	
3	50.0	3	2	150.0	0	10	55.0	5	
4	20.0	2	1	250.0	0	12	11.0	120	
5	60.0	0	10	23	0	15	95	120	
6	50.0	0	7	320	0	5	34.0	5	
7	30.0	20.0	100	27	10	15	61	5	
8	40.0	20.0	3	6	100	0	33	60	1.0
9	20.0	2.0	4	2	100	0	15	70	5
10	40.0	0	1	3	100	0	13	120	1.0
11	270.0	0	1000.0	1000.0	1000.0	0	1000.0	1000.0	
12	40.0	0	1	0	100	0	13	110	1.0
13	40.0	0	1	0	100	0	7	110	5
14	20.0	20.0	21	6	100	0	10	77	5
15	20.0	0	3	0	100	0	11	140	5
16	40.0	0.0	2	0	100	0	3	220	0
17	30.0	0	1	0	100	0	11	210	2.0

Source: Conducted by the researchers based on the Matlab program.

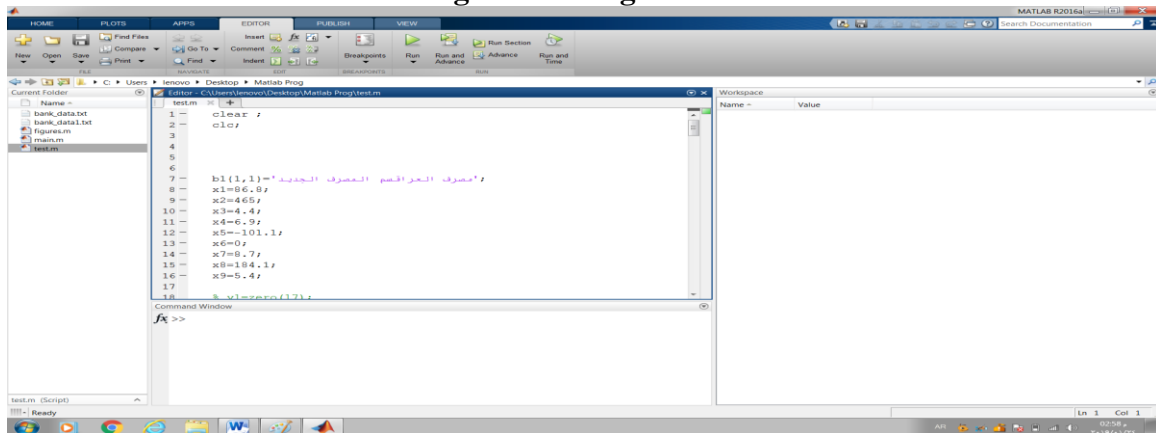
The results of the Camels criterion averages stored in the data file and shown in the interface above will be adopted as inputs to predict the DT. After that, during this stage, the researchers will apply the decision tree algorithm to the initialized stored data, where the program application process was based on conditional IF-Then instructions, as shown in the interface below.

**Interface (2) of the program application**



After the above program has been applied, this next stage is concerned with the process of storing the results that were reached through the application of the decision tree algorithm in new matrices in order to facilitate the process of interpreting and evaluating them in order to accurately determine the possible decisions for the banks in the research sample, as shown in interface (3) of the editor.

### Program Testing Interface

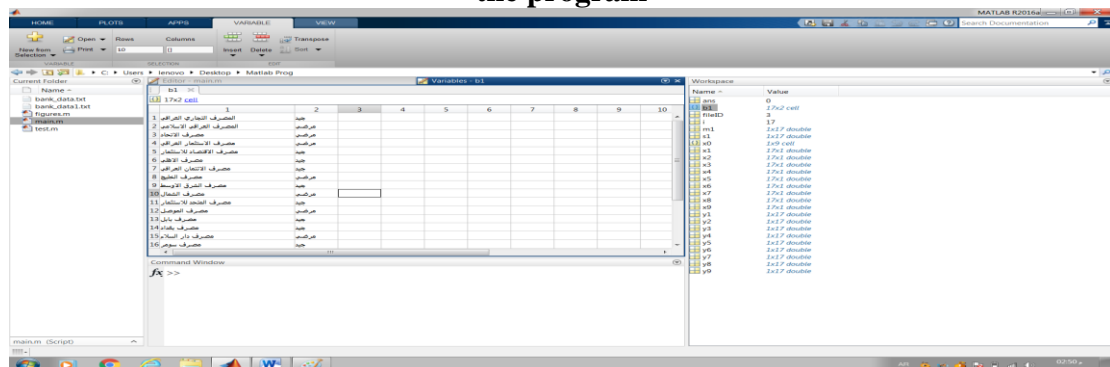


**Source:** Conducted by researchers based on the Matlab program.

$b1\{1,1\}$ ='Trade Bank of Iraq'  
 $b1\{3,1\}$ ='Union Bank of Iraq'

After completing the programming process shown above, the (Run) command was pressed, which means (execute) located at the top of the program interface in order to execute the program, where the prediction results according to the program using the decision tree algorithm were as shown in the interface (4).

#### Interface (4) Final results for prediction using the decision tree algorithm according to the program



**Source:** Conducted by researchers based on the Matlab program.

Based on the results reached in the decision tree algorithm, and as shown in the program interface (4), the research sample banks obtained the following evaluation:

**Table (7) Evaluation of the research sample banks according to the decision tree algorithm**

No.	Bank's name	Evaluation
1-	Trade Bank of Iraq	Good
2-	Union Bank of Iraq	Satisfactory

Based on the results reached, the researchers believe that the method of modern technologies represented by the decision tree technology is more accurate in providing information that helps in predicting the FC of banks and continuing their activity than traditional statistical methods due to many considerations, including accuracy, ease of interpretation and understanding, and

speed. It has value even with little data and other advantages enjoyed by these modern methods and the results reached.

#### **Fourth axis: Conclusions and recommendations**

##### **Conclusions:**

- 1- The banks in the research sample do not rely on modern techniques to predict FC, nor do they know the nature of predicting FC in advanced scientific methods.
- 2- Modern techniques represented by DT provide more accurate information that helps judge the extent of banks' continuity in practicing their activity.
- 3- The Camels criterion is one of the modern evaluation criteria that contributes significantly to evaluating the performance of banks and classifying them by providing an early warning system for bank failure based on a set of financial indicators. It is also much better than traditional methods represented by financial ratios.

##### **Recommendations:**

- 1- The Central Bank of Iraq should issue instructions or guidelines to apply modern techniques, in addition to directing private banks to hold seminars and awareness courses from experts specialized in this field in order to have a clear vision and idea about the nature of predicting financial failure and judging the continuity of the economic unit, in addition to developing the skills of bank employees through the use of advanced and modern programs.
- 2- Using DT technology to provide more accurate information in judging the continuity of Iraqi private banks. The researcher also recommends using other techniques, such as (id3 and c4 algorithms) in predicting banks' FC.
- 3- The necessity of banks adopting the CS because it is one of the modern regulatory standards that must be adhered to at present because it leads to a sound and healthy banking system free from errors and manipulations, in addition to its ability to correct and address errors and deviations and that it gives a comprehensive and realistic view of the reality of the banking system.

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