UNIVERSITY OF KHARTOUM

SCHOOL OF MANAGEMENT STUDIES

DEPARTMENT OF ACCOUNTING & FINANCE

PREDICTION OF FINANCIAL DISTRESS
IN SUDANESE COMMERCIAL BANKS

Thesis Submitted in Fulfillment of the Requirement of the Degree of
Ph. D. in Accounting

By: Ibrahim Elsiddig Ahmed
(2003)

Supervisor:    Dr. Ibrahim Ahmed Onour
Co-Supervisor: Dr. Abdelatif Imam Haj Omer
# Table of Contents

List of Contents 1
List of Tables & Figures 4
Acknowledgement 5
Abstract 6

**Chapter One: Introduction**

1-1 Introduction 11
1-2 Definition of Distress 14
1-3 The Research Problem 18
1-4 The Premises of the study 21
1-5 The Organization of the Study 28
1-6 Limitations of the Study 30

**Chapter Two: The Sudanese Financial System**

2-1 Introduction 32
2-2 Financial Regulations 36
2-3 Types of Financial Institutions 39
2-3-1: The Business of Banking 40
2-4 Islamic Banking 43
2-5 The Sudanese Banking Policy 46
2-5-1 The monetary and credit policy 47
2-6: Deposit Guarantee Mutual Fund 50
2-7: Financial Indicators 51

**Chapter Three: The Prediction of Financial Distress**

3-1 Introductions: Conceptual Aspects 56
Chapter Four: THE STRUCTURE OF BANKING INDUSTRY

Part (A): Banking Regulations & Capital Adequacy

4-1-A: The role of capital
4-2-A: Capital Adequacy
4-3-A: Why do regulators require banks to hold capital?
4-4-A: The Federal Deposit Insurance Corporation Improvement Act (FDICIA)
4-5-A: The Relations Between Capital Ratios and Bank Failures
4-6-A: Capital Enhancement Policies

Part (B): Banks Credit Risk

4-1-B: Credit Risk: An Introduction
4-2-B: Bank credit policy
4-3-B: Credit Risk Analysis
4-4-B: Expected Loss
4-5-B: How the models work?
4-6-B: Credit risk management
4-7-B: Principles for the management of credit risk
5-8-B: Measuring Management Qualities

Chapter Five: Research Methodology

5-1 Introduction
List of Tables & Figures

Figure 2-1: The Financial System 33
Figure 2-2: Sudanese Financial System 45
Table 2-1: Banks Financial Indicators 51
Table 2-2: Economic & Financial Indicators 52
Table 2-3: Balance Sheet Items 52
Table 2-4: Risk Weights 54
Figure 3-1: Bank Management Quality Model 70
Table (3-1): The Hazard Model Coefficients 74
Figure 3-2: The Neural Network 80
Figure 4-1: Capital Levels 98
Figure 5-1: Classification of EWS 112
Table 5-1: Ratios Used in the Analysis 148
Table 6-1: Means and Standard Deviations: 167
Table 6-2: The Model Variables 171
Table 6-3: Classification Results 174
Appendix (1): 202
Appendix (2): 208
Appendix (3): 223
Acknowledgement

In completing this study, I have benefited from the help and support of many people; it would be impossible to name them all. I would like to thank, first and foremost my supervisor Dr. Ibrahim Ahmed O’nour whose guidance, valuable and rich information helped the development of this model my longest-standing debt to him.

I would like to express my sincere appreciation to my co-supervisor Dr. Abdelatif Imam Haj Omer who encouraged and helped me to do my best.

My sincere appreciation for those who helped a lot in this study, especially those who gave me the basic and core information Dr. Sabir Mohamed Elhassan, Governor of the Bank of Sudan, Mr. Abdel Gadir Mohamed Ahmed, Director of the Taxation Chamber, my friends in the Bank of Sudan, Dr. Nagmeldin Hassan Ibrahim, and Mr. Bakri, my friend Awad Gibril from Zayed Research Centre and Tarig Gadoor who followed up the collection of data.

My gratitude and appreciations are to nice friends, my second family in the School of Management Studies, University of Khartoum for their considerable help and hospitality.

Last but not least, I would like to thank my family, relatives, and friends who always ask of my progress and encouraged me to carry
on. Special thanks are due to my brother Dr. Omer Ahmed Elsiddig and colleagues in Ajman University.

For errors, if any, the responsibility is solely mine and I shall be grateful for bringing these to my attention.
Abstract

Distress and bankruptcy prediction has been one of the most challenging tasks in accounting during the last 60 years. Academics in the fields of accounting and finance have actively studied bankruptcy since the groundbreaking work of Beaver (1966, 1968) and Altman (1968). In the last five years, three of the Sudanese Commercial Banks had completely failed and were liquidated, this is a phenomenon that needs to be studied and analyzed.

The study is the first to develop a model for the prediction of financial distress in Sudanese Commercial Banks. The study examined the analytical ability of financial ratios in the prediction of distress for a sample of six commercial banks during a five year period.

Multiple Discriminant Analysis (MDA) is used to determine the variables that distinguish between healthy and distressed banks. Many models in the literature are of great use to this study like the Z-Score model, Zeta model, CART model, CAMEL, and Chesser model. When we replicate Altman Z-Score after certain adjustments, the degree of its accuracy in Sudan and commercial banks is lower than its high degree of predictability in other countries and manufacturing companies.

The study started by the basic definition of distress as followed by the Basel Committee and classified healthy and distressed banks on that basis. This adds a contribution to the body of knowledge of financial distress in Sudan.
The financial ratios are found to be of great use to the prediction of distress and financial distress is affected by interacting factors that related directly to the liquidity, profitability, leverage and activity of commercial banks as can be seen in the model. Only financial variables are considered in this study because commercial banks are subject to the same conditions relevant to other entities.

Many financial ratios were analyzed and tested. 13 ratios representing four groups were found to be useful in the analysis. The study applied MDA to find only four ratios of high predictive power in distinguishing healthy from distressed commercial banks. This new model can be of great use for policy makers and commercial banks managers, and can be considered as a base for future studies.
ملخص

التنبؤ بالعمر والفشل المالي (الإفلاس) من التحديات التي تواجه المحاسبة منذ أكثر من خمسين عاما. قام الأكاديميون في مجال المحاسبة والتمويل بدراسة الإفلاس على أساس الدراسات التي أجريا كل من (بيفر) 1966 و 1968 و (ألنمان) 1968, بدأت ظاهرة الفشل المصرفى في السودان قبل خمس سنوات في ثلاثة من المصاصف التجارية, مما حاذا بنا إلى دراسة وتحليل هذه الظاهرة ووضع نموذج للتنبؤ بها.

تعد هذه أول دراسة قومية لوضع نموذج للتنبؤ (بالهشاشة) المالية في البنوك التجارية بالسودان. حيث تقوم هذه الدراسة باختبار قدرة النسب المالية في التنبؤ بحدث الهشاشة المالية، وتمت في ذلك على عينة تمثل النسبة من ستة بنوك تجارية. استخدمت الدراسة في ذلك سلسلة التحليل الإحصائي المتعدد وأخذ متوسط هذه النسب على مدى خمس سنوات مالية.

واستفادت الدراسة من مجموعة من النماذج المتاحة في الأدبيات وقامت بتطبيق بعضها على العينة المختارة من البنوك، مثل: نموذج (ألنمان)، (كارت)، وبعض نماذج الاحتمالات. ومن خلال ذلك نبين أن معظم هذه النماذج غير ملائمة لتطبيق بناء على تعريف لجنة (بازل) للضعف المالي. تم تصنيف البنوك إلى سليمة وأخرى متعرسة.

وأيضًا، وجدت الدراسة أن إضافة حقيقية للمعرفة الأدبية في مجال دراسات تقييم الأدء في المصاصف وبالتحديد الفشل المصرفي في السودان.

تم تحديد العوامل المتعددة للضعف والعمر المالي على أساس النسبة المالية وفق عوامل متداخلة تؤدي في نهاية مراحلها إلى معرفة البنوك السليمة من غيرها. لم تتوقف الدراسة على العوامل الاقتصادية والخارجية الأخرى لأن جميع هذه البنوك تخضع لنفس العوامل مما يتعين على هذه الأساس.

استخدمت الدراسة أكثر من أربعين نسبة وصلت بعد تثبيتها باستخدام نموذج (كارت) إلى ثلاث عشرة نسب، ومن ثم استخدم نموذج التحليل الإحصائي المتعدد حيث وجد أن النسب التي تميز بين البنوك عبارة عن أربع من بين النسبة التي استخدمت في الدراسة تحتوي على جميع أبواب النسب المذكورة أعلاه.
يعتبر النموذج المستخلص ذا فائدة عظيمة لعدة جهات أهمها: صناع القرار في إدارات البنك، المركزية المختلفة وإدارة البنوك التجارية وغيرها من البنوك كما يعد نموذج الدراسة أساس متين لمجموعة من الدراسات المستقبلية.
CHAPTER ONE
INTRODUCTION
CHAPTER ONE
INTRODUCTION

1-1 Introduction:

During the past two decades, many countries, including developed economies, developing countries, and economies in transition have experienced significant financial sector distress. Perhaps the most acute were brought about by the financial problems encountered in some emerging economies. The number of failures has risen from an average of seven per year prior to 1980s to failure rate in excess of 200 per year after mid-1990s in USA. The banking system problems that began in the mid-1990s in some Asian countries have also made apparent the probability and possibility of regional contagion. Hardy and Pazarbasioglu (1999), state that “recent events in East Asia have remind the world of how rapidly and with what disruptive force banking crises can erupt, and of how difficult it is to foresee the timing and ramification of these dramatic events.” Yet financial crises have a long history, and in recent decades many countries have experienced financial sector distress of various degrees of severity, and some have suffered repeated bouts (Lindgren, Garcia and Saal, 1996, provide a listing and discussion). Since the late 1980s Sudanese commercial banks, as part of the global economy, suffered a lot from financial problems and some of these banks had been declared as failed banks in the mid-1990s. With the number of failure surging, the need for more effective distress prediction models has become evident.
The proliferation of large-scale banking sector problems has raised widespread concern, as banking crises disrupt the flow of credit to household and enterprises, reducing investment and consumption and possibly forcing viable firms into bankruptcy. Banking crises may also jeopardize the functioning of the payments system and, by undermining confidence in domestic financial institutions; they may cause a decline in domestic saving and/or a large-scale capital outflow. Finally, a systematic crisis may force sound banks to close their doors. In most countries policy makers have attempted to shore up the consequences of banking crises through various types of intervention, ranging from the pursuit of a loose monetary policy to the bailout of insolvent financial institutions with public funds. Even when they are carefully designed, however rescue operations have several drawbacks: they are often very costly for the budget; they may allow inefficient banks to remain in business; they are likely to create the expectation of future bail-outs reducing incentives for adequate risk management by banks; managerial incentives are also weakened when—as it is often the case, rescue operations force healthy banks to bear the losses of distressed institutions. Finally loose monetary policy to shore up banking sector losses can be inflationary and, in countries with an exchange rate commitment, it may trigger a speculative attack against the currency.

Preventing the occurrence of systematic banking problems is undoubtedly a chief objective for policy-makers, and understanding the mechanisms that are behind the surge in banking crisis in the last ten years is a first step in this direction. Banking regulators are particularly interested in accurate failure-prediction models. The
governor of the Bank of Sudan (2000) is of the opinion that: financial
distress in Sudanese banks is detectable through the enhancement of
warning signals. If banking distress is accurately predicted; the failure
can easily be avoided, or the bailout costs minimized, through early
detection of an institution’s troubled status and intervention by
regulatory authorities. An accurate and timely identification of a
bank’s potential for crises would also assist in the targeting of audits
and allow for a more effective allocation of resources. Distress
prediction models help to identify causes of distress and thus lead to a
better understanding of bank operations. Finally, while an early-
warning system could never replace on-site examinations, it can
complement to on-site process by identifying troubled institutions that
need early examination or possible intervention.

Walen (1991) stated that: “It is believed that many of the failure
could have been avoided if management, examiners, and auditors had
recognized and reported on poor performance sufficiently early”.  
Because bank failures severely strain depositor’s resources and
undermine investor confidence, predicting distress and problem banks
early can help regulators minimize the bailout costs, and where
possible, avoid closing banks.
I-2 Definition of Distress:

There are different concepts of failure, such as: liquidation, bankruptcy, insolvency, fragility, default, crisis, failure, and distress.

Altman (1967) defined bankrupt firms as “those firms that are legally bankrupt and either placed in receivership or have been granted the right to recognize under the provisions of national bankruptcy act”.

Deakin (1972) defined bankruptcy to include “those firms which experienced bankruptcy, insolvency, or were otherwise liquidated for the benefit of creditors”.

Blum (1974) however adopted an operational definition of failure where “a firm is considered as bankrupt upon incurrence of events signifying an inability to pay debts as they come due, entrance into a bankruptcy proceeding, or an explicit agreement with creditors to reduce debt”.

Failure is a situation that arises when the realized rate of return on invested capital is significantly and continually lower than prevailing rates on similar investments. It may involve cases where, revenues are insufficient to cover costs; or the average return on investment is lower than the cost of capital.

Insolvency is another term exists when a firm cannot meet its current obligations, signifying a lack of liquidity. It occurs when the firm’s total liabilities exceed the fair valuation of its assets. i.e. the real net worth of the firm is negative.

Default involves the relationship between the debtor firm and the creditor class, and it can be technical or legal; Technical when the
debtor violates a condition of an agreement with a creditor and legally default can be used as a ground for legal action.

The Sudanese financial system is following the Basle definition and regulation for weak banks. The Basle Committee defines the weak bank as: a combination of or one of: (1) Inadequate capital or liquidity, (2) poor asset quality, (3) poor management, and (4) weak systems and controls.

In Sudan, the Companies Act of 1925 provided only for a company’s liquidation. No provision allowed corporations to recognize weakness and thereby remain in business. Under the 1925 Act, liquidation could take one of three cases:
1- Involuntary liquidation, through the court,
2- Voluntary liquidation, through a trustee decision, and
3- Liquidation through a trustee appointed by the court.

All these terminologies signify that the firm would face the problem as a going-concern. Financial distress can be considered as a first step for failure; here we can define distress as an unhealthy financial situation that may lead the bank to failure. Like other firms, banks can become financially distressed and fail. A bank failure occurs when a bank fails to pay depositors in full, or has not enough reserves left to meet its reserve requirements. In practice, regulators can close a bank when they deem its net worth to be too low. The higher a bank’s holding of reserves, marketable securities, and/or equity capital, the less likely is the bank to fail. This reality underscores the trade-off between bank safety and returns. Being too conservative lowers bank profitability.
Banking problems are usually difficult to identify empirically because of data limitations. The potential for a bank run is not directly observable and, once either a bank run or large-scale government intervention has occurred, the situation most likely will have been preceded by deterioration in the quality of assets held by banks. Identifying banking sector distress by the deterioration of bank asset quality is also difficult since direct market indicators of asset value are usually lacking. Given these conceptual and data limitations, most studies have employed a combination of events to identify and date the occurrence of significant banking sector problems. Of these events are the institutional events usually include forced closure, merger, or government intervention in the operations of financial institutions, runs on banks, or the extension of large-scale government assistance. Other indicators frequently include measures of non-performing assets, problem loans, and so on.

Bongini, Claessens, and Ferri (1999), define distress as “all those instances in which a financial institution has received external support as well as when those instances in which it was directly involved”. Financial distress is slightly a broader category than the above stated terms and may be identified in one of the following cases:

1) Closure of bank;
2) The merger with another bank;
3) The recapitalization of banks by the Central Bank; and
4) The inability of the bank to collect its loans for a considerable period following delay in the repayment of called deposits.

Generally, the weak bank is typical to the concerned distressed bank. The weak bank is defined by BIS as: “One whose liquidity or
solvent is or will be impaired unless there is a major improvement in its financial resources, risk profile, strategic business direction, risk management capabilities and/or quality of management”.

The definition focuses on a bank where there are potential or immediate threats to liquidity and solvency, rather than one with observable weaknesses that are isolated or temporary and which can normally be corrected by appropriate remedial action. Of course, all weaknesses, whatever their magnitude and character, must be addressed by the bank. They include, but not limited to, poor management, inadequate financial resources, absence of a long-term sustainable business strategy, weak asset quality, and poor systems and controls. Weakness of banks does not occur overnight. Problems that seem to emerge rapidly become a major concern to both banks’ managers and governors of central banks, and these problems need to be identified as soon as possible.

There are different types of weaknesses, but in practice of course, the individual bank weaknesses do not appear in isolation. Bank managers will have to deal with a range of different problems simultaneously. The key to turning around a distressed bank is to identify and quantify the problems and implement a comprehensive and credible corrective action plan. Depending on the circumstances, disclosure of the fact that the bank has embarked on such a plan may help in maintaining or restoring confidence in the bank.

It is important to distinguish between the symptoms and causes of bank problems. The symptoms of distressed banks are usually poor asset quality, lack of profitability, losses of capital, reputation problems, and/or liquidity. Different symptoms often emerge together.
Experiences from several countries indicate that liquidity problems have seldom occurred alone, so banking difficulties usually result from a combination of factors which attempts to determine and identify in this research.

1-3 The Research Problem:

According to most financial distress studies (as well as efficiency studies in banking, financial health, and risk), efficiency levels are eventually reflected through financial indicators (Shriives 1992, Ward 1994, Kwan and Eisnbeis 1997, Jacques and Nigro 1997, Santomero and Tresler 1998, and Kim and Santomero 1998). The studies cited above consider distress as a change in the financial status appropriately reflected through financial ratios. Many early warning models have been proposed for examining the financial viability of banks based on financial ratios of those institutions. They include Multiple Discriminate Analysis (MDA) (Stuhr and Vanwicklen1974, Sikney 1975, 1980), factors analysis and logit regression (Waste 1985, Gajewski 1989), event history analysis (Loonley et al. 1989), market data analysis (Demirguc-Kent1989, Thomas 1991), proportional hazard models (Whalen 1991), and belief networks (Sakar et al. 1996). Most of these models have focused on identifying relevant variables important in predicting financial distress. Their contribution to understanding of the factors that affect distressed banks was poor. Sakar and Sriram (2001) examined the role of probabilistic models for providing early warnings for bank failure. Some studies, such as Cole and Gunther (1995) for the United States and Gonzalez, Pazarbasioglu, and Billings (1997) for Mexico, have included as explanatory variables primarily bank-specific variables,
and looked at the experience of individual institutions. Another group of studies focuses primarily on macroeconomic variables, Kaminsky and Reinhart (1996). Hardy and Pazarbasioglu (1999) concluded that “the banking distress is associated with a largely contemporaneous fall in real gross domestic product growth, boom-bust cycles in inflation, credit expansion, capital inflows, rising real interest rates and a declining incremental capital output.

There are several reasons to address the research questions at empirical and conceptual levels. First, early literature on the subject has suggested that movements in interest rates, in stock returns, and in changes in deposits to currency ratio are key factors in understanding the occurrence of crises (Friedman and Shwartz 1963, and Minsky 1977). However, little statistical work has been expensed to document the significance of these variables in revealing the conditions conducive to crises. Two exceptions are Bordo (1985), and Gorton (1989). Second, the current literature on banking panics (Diamond and Dybvig 1983, Jacklin 1987, and William 1989) has failed to spellout their implications for generating mechanism of crises. Third, they offer little guidance on the choice of leading indicators for distress and impose very weak restrictions on financial variables both before and during distress periods. Finally, the Sudanese financial system is undergoing real developments in different respects, and has to go with Basel requirements of capital, regulations, and risks determination. The Basel standards need to be accompanied with banking studies at the local level, as the Basel conditions may not be fully applicable or able to predict distress, our study may be the main guide for distress prediction in Sudanese commercial banks.
The primary aim of this study is to detect the variables that help predicting commercial banks distress in Sudan. In the literature, there are different approaches tackling banks failure prediction. The study attempts to investigate the determinants of financial distress in Sudanese commercial banks, and the ability to predict the occurrence of this financial distress. In particular the study addresses the following questions:

- What are the variables reflecting the commercial banks distress and crises?
- Do banks that face the problem of distress or even showing failure have different characteristics from healthy ones? If so, are some those characteristics detectable before actual banks’ failure?
- Are there some important indicators that could act as pressure gauges by signaling immediate danger of banking distresses?
- Can these indicators be used to assess the degree of banking system distress before a crisis or failure occurs?
- What is the best method or model that can be used for the prediction of financial distress in Sudanese commercial banks?
1-4 The premises of the study:

To predict the factors and measures of financial distress in Sudanese Commercial Banks, the research depends on the published financial information as basic source to estimate the effective measures and influences of distress factors. Different methodologies can be used to predict the financial distress.

Failure prediction studies that use financial information as a base can be broadly classified into three groups:

(1) Uni-variate models, was initiated by Beaver (1966), Tamari (1966), and Wilcox (1971). The uni-variate models were the earlier to develop, and represented serious efforts to address the issue of predicting distress.

(2) Multivariate group model, which were used to discriminate failed from non-failed corporations. The multiple discriminant analysis (MDA) was the first to be adopted, (Altman, 1968). The model links a set of independent variables to a dependent variable that can take a discrete value. Studies by Abdul Aziz and Lawson (1989) and Abdul Aziz et al. (1988) combined the logit technique with the multiple discriminant analysis and cash flow variables with financial ratios (Altman ratios). Zavgren (1983) analyzed the significance of various financial variables and their coefficients in distinguishing between bankrupt and non-bankrupt companies.

(3) Neural network group, it is a new group of studies that have sought solutions for the MDA limitations through the use of artificial intelligence. This computing method does not require or assume
linearly separable or independent variables. Coast and Fant (1993) compared the classification performance of MDA and neural networks based on Altman’s Z-score ratios and found that the two methods obtain similar results. Also, similar results obtained by Altman et al. (1994). Altman (2000) argued that: “In general, ratios measuring profitability, liquidity, and solvency prevailed as the most significant indicators for predicting bankruptcy. The order of their importance is not clear since almost every study cited a different ratio as being the most effective indication of impeding problems”. Hence, the first of these premises or hypotheses of this study is that:

1-: “Financial ratios are the best predictors of financial distress in Sudanese commercial banks; the operational method to analyze their results is the multiple discriminant analysis”.

Many discussions of banking disorders and banking crises suggest that the risky banks are the ones that most likely to fail. There is no doubt that the bank that fails is the most susceptible to the crisis. The main question is whether can we know the failed banks before the occurrence of failure. This question acquires some importance because banks are using value at risk to measure their riskiness, and banking regulators are encouraging banks to do so (Altman and Saunders 2001). Correctly measured, it is hard to imagine a world in which reducing an individual bank’s riskiness does not reduce its probability of failing (e.g. Wheelock and Wilson 1995; and Kolari et al, 1999). We can generate our first hypothesis to be around the credit risk.
Chesser (1974) developed a model to predict default credits. The Chesser model is a banking study model that tried to look for banks’ credit risks and forecasted the degree of credit risk in banks generally.

The Chesser model was based on logit analysis and consisted of six variables:

\[
\begin{align*}
(X1) & \quad \frac{\text{Cash + marketable securities}}{\text{Total assets}} \\
(X2) & \quad \frac{\text{Net sales}}{\text{Cash + marketable securities}} \\
(X3) & \quad \frac{\text{EBIT}}{\text{Total assets}} \\
(X4) & \quad \frac{\text{Total debt}}{\text{Total assets}} \\
(X5) & \quad \frac{\text{Fixed assets}}{\text{Net worth}} \\
(X6) & \quad \frac{\text{Working capital}}{\text{net sales}}
\end{align*}
\]

The estimated coefficients are:

\[
Y = -2.0434 - 5.24X1 + 0.0053X2 - 6.6507X3 + 4.4009X4 - 0.0791X5 - 0.1020X6.
\]

Where: \(Y\) is the overall performance.  
\((X1, \ldots \ldots X6)\) are the explanatory variables.

The use of the Chesser model in the banking sector can be criticized in certain aspects:

- Some ratios used in this model do not suit the banking sector, as in X2 and X6; the model used net sales as one of the component of the ratios while it is not logical to use the word sales in banks.
• Net sales are not generated from current assets only as in the second ratio (X2) in the model. This ratio was again inversed in the sixth variable (X6)

The model was mainly concerned with liquidity measures but with no consideration to liabilities or deposits.

2-: The primary danger in granting credit is the possibility that borrowers will not repay the loan; the credit risk is the risk that a credit loss may occur at some future point in time. Thus credit risk is the uncertainty associated with a borrower’s loan repayments. This risk can be measured in banks through the bank’s leverage ratio and other relevant ratios.

*Hence, credit risk embodied in the banks’ lending process is considered as a real source of financial distress in Sudanese commercial bank.*

Capital decision is analyzed within the theoretical framework developed by Baltensperger (1973). The individual bank maximizes its profit by choosing an optimal ratio of capital to debt within a competitive environment. Baltensperger model challenges the Modigliani and Miller theorem (1958) in pointing out the differences between callable debt like deposits issued by commercial banks, and capital. The amount of precautionary reserves (Selgin, 1994) depends on the turnover of the callable debt. On the other hand there exists a relationship between the amount of inside money issued by the individual bank and the amount of equity it holds. Equity represents a buffer against any decrease in the real value of assets. In other words, in a risk / return analysis, an individual bank that holds a lower level
of equity should pay a higher nominal interest rate to attract depositors, that is paying a higher risk premium. But at the same time holding equity reduces the capacity of the bank to create money. Janson (2000) state “the higher is the capital ratio, the higher the price customers are ready to pay for holding callable debt because it signals the quality of liquidity services offered”. Shrives and Dahl (2002), state, “Risk exposure and capital levels are simultaneously related, and that the majority of banks mitigate the effects of increases in capital levels by increasing asset risk posture, and vice versa”.

Frydman, Altman, and Kao (1985), developed the CART model (Classification and Regression Tree) to predict banks’ financial problems. Data mining was used to select the best set of variables. The most popular and powerful data-mining tool is the CART. In the CART model, all possible ratios or variables expected to affect banking distress are selected. Therefore, all collected data can be used. They used a binary classification tree around four ratios: Cash flow / total debt, total debt / total assets, retained earnings / total assets, and cash /total revenues. Then, we can develop the third hypothesis of this study on the base of the above variables:

3-: **Financial distress is a result of the interacted financial factors that affect the financial profile of the commercial bank.**

As we will see, the Z-score model is a linear analysis in that five measures are objectively weighted and summed up to arrive at an overall score that then becomes the basis for classification of firms into one of the priori groupings (distressed and non distressed). Because of the large number of variables found to be significant
indicators of corporate problems in past studies, a list of 22 potentially helpful variables (ratios) were evaluated by (Altman, 1993). The variables are classified into five standard ratio categories, including liquidity, profitability, leverage, solvency, and activity. The final discriminate function is as follows:

\[ Z = 0.012X_1 + 0.014X_2 + 0.033X_3 + 0.006X_4 + 0.999X_5 \]

*Where: \( X_1 = \text{Working capital / total assets}, \)
\( X_2 = \text{Retained earnings / total assets}, \)
\( X_3 = \text{EBIT / total assets}, \)
\( X_4 = \text{Market value of equity / book value of total liabilities}, \)
\( X_5 = \text{Sales / total assets, and} \)
\( Z = \text{Overall index.} \)

The revised Z-model (2000) is as follows:

\[ Z = 0.717X_1 + 0.847X_2 + 3.107X_3 + 0.420X_4 + 0.998X_5 \]

Therefore, the fourth premises or hypothesis can then be stated as follows:

4:- *The variables of the Z-model are considered in our model to predict financial distress in Sudanese commercial banks.*

The ZETA credit risk model was also developed by Altman, Haldeman and Naryanan (1977). It was a second-generation model with several enhancements to the original Z-score approach. The variables are:

\( X_1 = \text{Return on assets = EBIT / total assets} \)
\( X_2 = \text{Stability of earnings, which indicates the business risk.} \)
\( X_3 = \text{Debt service, measured by the familiar interest coverage ratio.} \)
\( X_4 = \text{Cumulative profitability = Retained earnings / total assets.} \)
\( X_5 = \text{Liquidity, measured by the familiar current ratio.} \)
X6 = Capitalization = Equity / total capital.
X7 = Size, measured by the firms’ total assets.

The continuing erosion of confidence in the banking system constitutes perhaps a significant factor that treat the continuing survival of many commercial banks within the system. Stability of the economy is equally threatened by the increasing weakness in the banking system. The works of Soyibo (1994), Sobodo and Akiode (1994) and Adekanye (1993) all point to the inadequacy of bank supervision and management as a source of banking distress. Macroeconomic policies can be considered as an important determinant of banking distress. This factor can be evaluated through the investigation of rules and regulations imposed by the policy makers or the central bank. There may be a policy bias toward a category or group of banks within the banking system. The Bank of Sudan issued many rules, policies, and guides to apply tight controls on commercial banks before and after financial liberalization policy. The ceilings of finance, sectors to be financed, exchange rates, nomination of the bank’s management, methods of evaluation, liquidity and reserves and the establishment of new branches are set by the Bank of Sudan. Relevant to the above show, we can say, and then the fifth hypothesis can be set as follows:

5-: Banking regulations play an important role in the stability of banking system in Sudan.
1-5 The Organization of the Study:

The study was logically organized into seven chapters to carry out the stated objective and to test the five hypotheses assumed by the study. All hypotheses are about the use of financial ratios and their ability to predict financial distress in commercial banks.

Chapter One is an introductory chapter where the definition of distress, the problem of the study, the objectives of the study, the hypotheses, organization, and the limitations of the study are specified.

Chapter Two is basically concerned with the Sudanese Financial System. The chapter started with an abbreviated literature about the role, types, and components of the financial system generally, and then it showed the components of the Sudanese Financial System with concentration on the banks, banking system, the role of the Central Bank, its banking and credit policies, and some important economic and financial indicators.

Chapter Three was developed to present the models and literature relevant to the prediction of financial distress. The study overviewed different models concentrating on their limitations or difficulties and finally selected the multiple discriminant analysis (MDA) to be applied for the prediction of distress.
Chapter Four is a literature chapter about the banking industry. This chapter is divided into two main parts: Part (A) is about the capital adequacy of banks, while part (B) is about the credit risk. The first section of this wide chapter was about an important and critical factors for bank’s managers, this is why regulations and capital adequacy was the core. The chapter covered the basic concepts of capital, its adequacy, its relation with distress, who regulates capital, and how capital is regulated. Here, a strong relationship between capital and regulations is stated.

Section (B) of chapter four presented the concepts of credit risk as one of the main hypotheses stated in chapter one. The chapter overviewed the measurement and management of credit risk. Many relevant issues are covered such as: types of risks, credit risk in commercial banks, methods that measures credit risk, credit policies, credit scoring system, credit management, and the management principles applied by the Basel Accord.

Chapter Five is a research methodology chapter that discusses the collection of data, data mining approach, the way data is analyzed, the multiple discriminant analysis as a tool for analysing data and building the new model.

Chapter Six is the analytical and core chapter of the study. The chapter starts by the replication of some models stated in the hypotheses and chapter one of the
study. The second part of the chapter is concerned with
the development of the new model of distress prediction.
It shows how the statistical techniques are used, and how
the new model is build.

Chapter Seven is the last chapter of the study, in
which the study presents a summary of the previous
chapters, the conclusions and the final recommendations
of the study.

1-6 Limitations of the study:
Though this study can be considered as a new contribution to the body
of knowledge relating to the prediction of distress in Sudanese
Commercial Banks but the study may not be free of some constraints
or limitations. One can state some of the limitations as follows:

• The literature reviewed relates to industrial countries, and
as such may not be replicated to the case of Sudan. In
addition this study is the first to investigate prediction of
distress in Sudanese commercial banks, as there are no
previous studies about the prediction of distress in Sudan
to depend on their results, so there is no base of
comparison to determine the efficiency of this study.

• The study concentrates only on the factors of financial
distress, some other factors are not considered in this
study. The study ignores macroeconomic factors because
all banks are similarly affected by these factors, so they
cannot differentiate between the banks under typical
environment.
• Some banks had already failed; this means that, the data to provide useful comparison for some periods is not available. Over and above all, some relevant information is not easily provided, like the ratio of non-performing loans in some banks.

• Most prior bank failure prediction models have demonstrated high levels of predictive accuracy because they were tested on large samples of matched pairs. Unlike these studies, our study selects a sample of small size that may not give the same predictability level but the sample is definitely relevant to the population (Commercial banks in Sudan).

CHAPTER TWO
CHAPTER TWO

The Sudanese Financial System

2-1: Introduction:

The financial system provides mechanisms to transfer funds from surplus units to deficit units or from savers to borrowers. Savers are suppliers of funds, providing funds to borrowers in return for promises of repayment of even more funds in the future. Borrowers are demanders of funds for customer durables, houses, or business plant and equipment, promising to repay borrowed funds based on their expectation of having higher incomes in the future. These promises are financial liabilities for the borrower, that is, both a
source of funds and a claim against the borrower’s future income. Conversely, the promises, or IOUs, are financial assets for savers, that is, both a use of funds and a claim on the borrower’s future income. The financial system channels funds from savers to borrowers and channels returns back to savers, both directly and indirectly. Savers and borrowers can be households, businesses, or governments, both domestic and foreign. Financial markets, such as the stock market or the bond market, issue claims on individual borrowers directly to savers. Financial institutions or intermediaries, such as banks, mutual funds, and insurance companies act as go-betweens by holding a portfolio of assets and issuing claims based on that portfolio to savers. The figure below will show the diagram of the financial system:

Figure (2-1)

*The Financial System*

[Diagram showing the financial system with savers, borrowers, financial markets, and financial intermediaries with arrows indicating the flow of funds and returns.]
The financial system provides three key services to savers and borrowers:

1) **Risk sharing**: one of the greatest advantages of using the financial system to match individual savers and borrowers is that it allows the sharing of risks. Risk refers to the chance that the value of financial assets will rise or fall relative to what you expect. The financial system provides risk sharing by allowing savers to hold many assets (portfolio). This splitting of wealth into many assets is known as diversification. As long as the individual returns do not vary in the same way, the risk of severe fluctuations in a portfolio’s value will be reduced.

2) **Liquidity**: It refers to the ease with which an asset can be exchanged for other assets or for goods and services. Savers care
about liquidity of financial assets. No asset is totally liquid. However, financial system provides trading systems for making assets more liquid.

3) Information: The third service the financial system provides to savers and borrowers is to gather and communicate information, or facts about borrowers and expectations about returns on financial assets. To gather information involves finding out about prospective borrowers and what they will do with borrowed funds. When borrowers possess information about their opportunities or activities that they do not disclose to lenders or creditors, a condition of asymmetric information exists.

Savers look to banks to obtain financial assets because: first, savers can hold claims against a diversified portfolio of loans through banks, thereby obtaining risk-sharing benefits. In addition, bank deposits meet savers’ demands for liquidity. Finally, banks are actively involved in gathering and monitoring information about borrowers. As delegated monitors, banks reduce information costs for individual savers.

Two principal challenges are involved in the relationship between savers and banks:

1) Managing moral hazard problems: Banks are important in reducing information costs for savers. The moral hazard problems can be solved through: (i) Investing in debt rather than equity, and
   (ii) Requiring bankers to put their own funds at risk.

2) Managing liquidity risk: In their dealings with savers, banks are faced with liquidity risk, or the possibility that depositors may collectively decide to withdraw more funds than the bank has on hand.
Such withdrawals would force the bank to liquidate relatively illiquid loans and probably receive less than their full value. The challenge to manage liquidity risk is to reduce risk exposure without sacrificing too much profitability.

The principal challenges involved in the relationship between the bank and the borrowers are:

1) Managing credits risk: Banks make profits from the spread between the interest rate they charge to borrowers and the interest rate they pay to depositors. To manage credit risk of individual loans, banks use credit risk analysis to examine borrowers and determine the appropriate interest rate to charge.

2) Managing interest rate risk: The profits that banks earn from lenders to borrowers are exposed to risk due to changes in interest rates in financial markets, called interest rate risk. Recall that changes in interest rates affect the value of banks’ financial assets and liabilities. Banks must be able to compare the interest sensitivity of the values of different assets and liabilities.

To manage interest rate risk, banks must begin by evaluating the exposure of their portfolios to the risk of fluctuations in market interest rates. One measure is the duration of a bank asset or liability, which is the responsiveness (of the percentage change) the asset’s or liability’s market value to a percentage change in the market interest rate. The difference between the duration averages of assets and liabilities is known as the duration gap.
2-2: Financial Regulation:

The government of every country is the regulator of financial markets and institutions around the world. Over time, regulations imposed by governments change, causing the services and instruments offered by markets or institutions to change.

Policymakers are concerned about the health of the banking industry because of banks’ importance in reducing information costs in the financial system. The financial failure of banks hurts the ability of less well-known borrowers to obtain loans, thereby, reducing the efficiency of the saving-investment process. For banks, government intervention focuses directly on maintaining the financial health of the lender. Concern over the financial stability of the banking industry prompted three types of government intervention:
(1) The creation of a lender of last resort (or the banker’s bank),
(2) The introduction of deposit insurance system to guarantee the value of savers’ deposits, and
(3) To apply restrictions on competition in the banking industry. Restrictions may be in different forms: (a) restrictions on geographic branches, (b) restrictions on permissible activities of banks, (c) selection of sectors to be financed, (d) determination of ceilings, and (e) application of minimum capital requirements.

Three reasons account for most financial regulation:

1) Provision of information: the regulation of information is a key factor to provide confidence and good dealing between savers and borrowers.

2) Maintenance of financial stability: Most regulation of the financial system is concerned with its stability, meaning
the ability of the financial markets and intermediaries to provide the three key services in the face of economic disturbances. Policymakers are concerned about the financial soundness of intermediaries who hold the financial assets.

3) Advancement of other policy objectives: Financial regulations also may be used to further public policy objectives unrelated to the efficiency of the financial system. These objectives include controlling the money supply. Because banks affect movements in the money supply, which in turn influence the economic variables that affect people’s daily lives, policymakers have implemented rules to facilitate control of the quantity of money. For example, the bank of Sudan system requires banks to hold a specified fraction of their deposits in cash or in accounts with the central bank, giving the Bank of Sudan some control over the money supply.

The central banks generally use two methods to handle bank failures. They are called the payoff method and the purchase and assumption method. In the payoff method, the central bank closes the bank and pays the insured depositors immediately. To cover its funds, the central bank draws payments from the bank’s remaining funds and net worth, including the sale of the bank’s assets. If those funds are insufficient, the central bank makes up the difference from its insurance reserves.

The central banks prefer to use the purchase and assumption method to keep a failed bank running by finding a financial institution
willing to take over the bank in order to gain entry into new geographic markets and access to the failed bank’s goodwill (its network of customer relationship).

2-3: Types of Financial Institutions:
Financial institutions fall into five broad groups:

(1) Securities market institutions, made up of investment banks, brokers and dealers, and organized exchanges;

(2) Investment institutions, consisting of mutual funds and finance companies;

(3) Contractual saving institutions, including insurance companies and pension funds;

(4) Depository institutions, made up of commercial banks, savings and loan associations, mutual savings banks, and credit unions; and

(5) Government financial institutions.
The last four types can be considered as pure financial intermediaries.

2-3-1: The Business of Banking:

Banking is a business; that is, banks fill a market need for a service and earn a profit by charging customers for that service. As intermediaries, banks’ primary profit-making activities entail acquiring funds at a cost from savers and lending those funds to borrowers, adding value by providing risk-sharing, liquidity, and information services.

A natural way to know the sources and uses of banks’ funds, and hence banks’ profit-making activities, is to look at their balance sheets*.

The Sudanese financial system is composed of direct financial institutions (financial markets) which is represented by the Khartoum
Stock Exchange, and financial intermediaries which are banking and non-banking financial institutions. The banking system in Sudan is composed of three types of banks; investment banks, specialized banks, and commercial banks. The commercial banks, which are our concern in this study, are of three types: foreign banks, governmental banks, and joint ownership banks. The bank of Sudan (BOS) is the central bank, which is the regulator of all these banks and it is the top level of the system.

*A balance sheet is simply a statement showing uses of acquired funds, (assets), the sources of funds, (liabilities), and the difference between the two, (net worth). Liabilities, include, checkable deposits, non-transaction deposits, and borrowings. Assets include, cash items, securities investments, funds, loans, bank’s fixed assets, and other holdings.

A critical area of reform in Sudan is the country’s weak banking sector. In 1996 there were 26 commercial banks operating in Sudan comprised of four state-owned banks, a handful of well established private operations and small banks established by consortiums of local business families trying to get around the tortuously bureaucratic and low state-owned banks.

With the current complexity in the banking system, the actual need for these small banks has dropped and many are suffering.

The most significant problem is the banks’ narrow capital and deposit base, eroded by the high inflation rate of the past years. According to The Bank of Sudan, ten Sudanese banks are classified as undercapitalized, with capital adequacy ratio below 8%. Non-
performing loans in the sector are also high, representing 18% of total loans.

One of the main victims of the weakness in the banking system in Sudan is the business sector. Credit to the private sector has declined in recent years, with the agricultural, industrial and construction sectors being particularly affected. Aside from the banking sector’s financial weakness lending to the private sector has been hindered by a number of factors. IMF points out that an astonishing 85% of past loans in the agricultural sector have been unrecoverable. Additionally, the cost of borrowing has remained high, with interest rates as high as 17% in real terms in 2000.

The current governor of the Bank of Sudan, views that: the main challenge facing the Bank of Sudan and the banking sector in general is how to reform and restructure banks in Sudan to be able to cope with the very fast change within the Sudanese economy and to be on an international level. The Sudanese economy is undergoing a very major transformation with the discovery of oil and inflow of foreign direct investment in a substantial way. This in turn will create new challenges for the banking sector regarding the demand for banking. The first step in this process to the policymakers will be the consolidation of the banking sector in order to improve its financial strength. Enforcement of capital adequacy requirements means the Central Bank expects that banks will be forced to restructure their internal operations, while the smaller banks will be forced to either merge or be liquidated. He also plans to increase the availability of credit to the private sector by developing alternative modes of Islamic financing specialized for agriculture, improving the legal framework
to make collections of loan repayments less difficult and introducing incentives to strengthen the bank’s deposit base.

Achieving these reforms will represent a certain culmination of the Bank of Sudan’s efforts in transforming the sector since independence. BOS* has supervised the evolution of the banking sector since the time it consisted of just a few branches of foreign banks.

* The Bank of Sudan was established in 1960. By 1972, one Sudanese bank had been established after which the sector was nationalized by the socialist government at that time.

2-4 Islamic Banks:
In the last two decades, Islamic banks have grown in number and size around the world. Islamic banks operate in over sixty countries, most of them in the Middle East and Asia. R. Aggarwal states that: “In three countries, Iran, Pakistan, and Sudan, the entire banking system has been converted to Islamic banking.” In the other countries, the banking systems are still dominated by conventional banking institutions operating alongside Islamic banks. Even so, Islamic banking is the fastest growing segment of the credit market in Muslim countries that have Islamic banks: their market share has risen from 2% in the late of 1970s to about 19% in 2000, as measured by assets in the banking system (Babai, 2000).
Islamic banks are supposed to offer instruments consistent with the religious beliefs and cultural characteristics of Muslim societies. According to prevailing interpretations of Islamic law, financial instruments should emphasize profit-and-loss sharing (equity), (Interest is prohibited). Islamic banks and the monetary authorities of the countries have developed alternative “interest free” financing techniques; they have been based on two principles: the profit-and-loss sharing (PLS), and the mark-up. One of the benefits of these mark-up contracts relative to the standard Western debt contracts is that, in cases of default, there is no ambiguity about control of the assets. There are many instruments such as: Mudaraba, Murabaha, Musharaka, Ijara, Istinaa, Salam…etc.

The biggest shift for the sector came in 1983 when the government at that time made the decision to implement Sharia, under which all non-Islamic banks were to conform their operations according to Islamic financial principles. Real change came in 1992, when the BOS oversaw the process to the extent that all banks, including foreign banks with branches in Khartoum, according to Islamic practices and then the establishment of The Fatwa department in the BOS.

What is really concerned in this study is that: the financial statements prepared by the Sudanese commercial banks are unified. The financial disclosure in Sudanese Commercial banks both Islamic and traditional is made following the Islamic standards, so there is no difference between the banks relevant to the financial statements.

Recently, we can present the current financial system in Sudan in the following diagram. It includes the banking system and other non-financial intermediaries and non-intermediaries.
Sudanese financial system: Figure (2-2)
2-5 The Sudanese Banking Policy:

Bank of Sudan through the issuance and execution of banking policies assumes its supervising and promotional role over banks in accordance with the provisions of the banks’ practice act of 1991 and its subordinate regulations of implementation.

The bank of Sudan by following successful policies was able to reduce the very high inflation rates in the early 1990s to about 5% with a stable economy in 2000. The BOS set an ultimate time for the banking restructure by the end of 2002, by that time the banks must have either increased their paid-up capital to $11.5 million, or to merge or liquidate. Due to this policy, some of the banks were about
to fail, such as the Bank of Khartoum, the country’s largest and 100% owned by the government has raised its paid-up capital from $1.3 million in year 2000 to $9.6 million in 2002. Tadamon Islamic Bank, established in 1983, has chosen to increase its paid-up capital, with a current capital adequacy ratio of 15%, well above the 8% requirement set by the BOS and Basel Accord.

Through persistent and robust follow-up for the banks’ performance, banking policies normally witness developments and refinements to adapt to the prevailing requisites and circumstances of the local and global banking industry environment. Here, we need to highlight the main policies and their consequences on the development and promotion of the banking practice and their contribution to the achievement of the broad macroeconomic objectives.

In the year, 1999 BOS launched a comprehensive banking reform policy with a major aim to solve the problem of banking distress in the previous few years, to adapt with economic liberalization policies, to meet the stipulations of the Basel Committee Accord, and to cope with the trend of economic globalization. To effectively achieve the goals of that policy, detailed annual implementation programs were drawn in the areas of liquidity management, banking system development, foreign exchange market, banking services automation, and Islamization of banking system. These broad policies were achieved through the following policies and programs, in year 2000:

2-5-1 The monetary and credit policy:
The monetary and credit policy for the year 2000 was issued in compliance with the prescribed macro-economic objectives, some of these objectives are:

- Stabilizing the exchange rate,
- Realizing a GDP growth rate that was 6.5% in 2000.
- Reducing the inflation rate to 12% in 2000 or less then.

These objectives are to be achieved by financing the public sector through banks, Murabaha credit should not exceed 30% of the total finance, allowing banks to extend credit in foreign exchange, and strict adherence to the manual of the Murabaha mode of finance. On the other hand, the credit policy affected the following:

- Legal reserve ratio in local currency is reduced from 28% to 15%, while in foreign currency is increased from 6% to 15%;
- The minimum ratio of credit to be extended to the priority sectors from the total credits reduced form 95% to 90%; and
- The minimum Murabaha profit margin is reduced form 20% to 18%.

*The Banking System Re-structuring and Reform Program:*

There was a high need for the restructure and reform program, specifically after the failure that faced some banks and the need to increase capital to reduce the financial distress. This program primarily aims at creating large-scale financing units capable of withstanding the challenge of the international banking and
globalization. The major components of the Sudanese Banking Reform program are:

- Minimum capital requirements: For the banks to strengthen their financial positions, they have to raise additional capital. The minimum capital required for each bank decided to be SD 3 billion and to be paid in full during the period of the program (2000 – 2002).

- Bank’s merger: Banks’ merger would be optional and BOS will offer the necessary technical assistance in deciding the determinants and indicators for the merger-groupings. Most of the banks selected capital augmentation over merger.

- Public sector commercial banks: Public commercial banks are subject to the mentioned policies to cope with competition and strengthen their positions. Certain proposals were submitted by the BOS to the ministry of finance regarding public commercial banks. They would be restructured through privatization.

- The Non-performing Loans: The non-performing loans are the defaulted loans. These loans started to increase with high rates relevant to the total finance of the banking sector, and they were considered as a determinant factor of financial distress in many banks. The Bank of Sudan exerted many efforts to decrease the ratio of non-performing loan from 24% in 1999 to only 16% in 2000. Specialized corporation was issued to administer this acute problem.
Liquidity Management: The monetary authority continues applying the central bank Musharaka certificates “CMCs” and the government Musharaka certificates “GMCs” as new instruments for managing the liquidity and generating real financial resources to finance the budget deficit as an alternative of borrowing from the banking system. The BOS extend credit to banks through the financing windows of direct finance, Mudaraba, or deficit liquidity financing.

Banking Technology: As a result of modernization and automation of the banking business, a specialized administration had been established. The new administration was able to link the banks by SWIFT services through Shamikh center in the Bank of Sudan.

The Sharia High Supervisory Board: Its objective is to supervise the adherence of banks to the Islamic methods and modes of finance. This board was established in 1992, a number of Fatwas and resolutions were issued to the banks and the central bank. This board had issued an important rule that asked all banks to follow the Islamic standards in their financial reports.

To have efficient policies some other departments were established to face banking failures, such as the deposit guarantee fund.

2-6 Deposit Guarantee Mutual Fund:
This fund was established to compensate injured depositors as a result of financial crises that face commercial banks in Sudan. The banks’ contributions in this fund were SD. 177 million in 1999 compared to SD. 125 million in 1998 (i.e. 41% increased). The excess of the fund’s resources (319m) was invested in investment deposits. The recorded injured depositors were 2777 depositor, 2475 of them had been compensated (89%) by the guarantee fund.

The fund was able to issue some important portfolios in order to protect depositors and to increase the confidence in the banking system, some of these portfolios are:

1) A guarantee portfolio for current and saving deposits, to be financed by the central bank and the government.
2) A portfolio guarantee for investment deposits, issued by investment depositors.
3) The insolvency portfolio, financed by the government, the central bank, and the commercial banks.

2-7: Financial Indicators:

Some of the basic financial indicators of the Sudanese commercial banks provided by the Bank of Sudan, can be summarized below:

*Table (2-1) Financial Indicators*
The bank ratio  1997  1998  1999  2000
1  Deposits/Total Liabilities  41%  37%  35%  55%
2  Capital & Reserves / Total Debt  6%  6%  5.7%  9%
3  Total Finance / Total Assets  18%  14%  11%  22%
4  Total Finance / Total Deposits  43%  39%  32.8%  40.2%
5  Current Assets / Current Deposits  29%  26%  1%  0.7%

Source: Bank of Sudan Reports

It is clear from the above table that, the liquidity position is decreasing at increasing rates. The liquidity risk is very high in the last years, as it became less than 1% in year 2000, compared to 29% in 1997. The capital to total debt is stable and reasonable due to the reserve policy applied by the Bank of Sudan. The deposits represent about 50% of the banks’ liabilities; this means that the banks are to some extent able to attract depositors. The average rate of finance to total assets is less than 20%. This a low rate due to the high degree of risk inherited in the lending process.

Below are some selected economic and financial indicators in Sudan during 1996 – 1999:  

| Table (2-2) Economic indicators |
|--------------------------|-------|-------|-------|-------|

<table>
<thead>
<tr>
<th></th>
<th>1997</th>
<th>1998</th>
<th>1999</th>
<th>2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital &amp; Reserves</td>
<td>14678</td>
<td>20338</td>
<td>24464</td>
<td>32200</td>
</tr>
<tr>
<td>Deposits</td>
<td>96754</td>
<td>120112</td>
<td>145519</td>
<td>197224</td>
</tr>
<tr>
<td>Total Assets</td>
<td>237508</td>
<td>328176</td>
<td>424848</td>
<td>357068</td>
</tr>
</tbody>
</table>

To achieve financial stability and capital adequacy policy, the Bank of Sudan exerted many efforts to help the commercial banks. In its circular (8/2002) some important efforts can be noted:
1) Excess in assets and investments revaluations are to be added to the capital with a percentage of 45% with a condition of not to exceed 100% of the original capital.

2) A provision of 2% of total finance to be added to the capital and not to exceed 1.25% of the weighted risky assets.

3) The Bank of Sudan issued the risk weights of the banks’ assets in the table (2-4).

More data and information about recent economic and financial indicators that represent liquidity, performance indicators in commercial banks, components of money supply, flow of credit, and the Central Bank and Government certificates are available in (Appendix 3).

Table (2-4)

Some risk weights of bank’s assets:
<table>
<thead>
<tr>
<th>Item</th>
<th>Risk weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash (in and outside the bank)</td>
<td>0 %</td>
</tr>
<tr>
<td>Cash with correspondents</td>
<td>20 %</td>
</tr>
<tr>
<td>Checks Receivables</td>
<td>0 %</td>
</tr>
<tr>
<td>Government Finance</td>
<td>0 %</td>
</tr>
<tr>
<td>Institutional Finance</td>
<td>50 %</td>
</tr>
<tr>
<td>Finance with estate guarantee</td>
<td>30 %</td>
</tr>
<tr>
<td>Finance with personal guarantee</td>
<td>20 %</td>
</tr>
<tr>
<td>Finance with joint storage system</td>
<td>50 %</td>
</tr>
<tr>
<td>Finance with customers guarantees</td>
<td>100 %</td>
</tr>
<tr>
<td>Salam’s goods</td>
<td>25 % - 100 %</td>
</tr>
<tr>
<td>Commercial goods</td>
<td>30 %</td>
</tr>
<tr>
<td>Non-durable goods</td>
<td>30 % - 100 %</td>
</tr>
<tr>
<td>Finance for stock listed companies</td>
<td>50 %</td>
</tr>
<tr>
<td>Finance for non-listed companies</td>
<td>100 %</td>
</tr>
<tr>
<td>Letters of credit</td>
<td>20 %</td>
</tr>
<tr>
<td>Fixed assets (BV)</td>
<td>100 %</td>
</tr>
<tr>
<td>Common shares</td>
<td>100 %</td>
</tr>
<tr>
<td>Other Bills</td>
<td>100 %</td>
</tr>
<tr>
<td>Government certificates (CMC, and GMC)</td>
<td>0 %</td>
</tr>
</tbody>
</table>

Source: Bank of Sudan
CHAPTER THREE
THE PREDICTION OF FINANCIAL DISTRESS

CHAPTER THREE
The Prediction of Distress
3-1 Introductions: Conceptual Aspects

In this chapter we aim to present the models of predicting financial distress in the literature, the measurement of distress, the variables or determinants of financial distress, the investigation of the prediction models to the banking system in developing countries (Sudan), and critical appraisal to these models.

Distress and bankruptcy prediction has been one of the most challenging tasks in accounting during the last 60 years. Academics in the fields of accounting and finance have actively studied bankruptcy since the work of Beaver (1966, 1968) and Altman (1968).

In the 1980s, the number of U.S failures increased significantly. For example; during the period 1950 to 1980, bank failures averaged less than seven per year, whereas during the period 1986 to 1991, it averaged 175 per year (Barr and Siems 1994). It is believed that many of these failures could have been avoided if management, examiners, and auditors had recognized and reported on poor performance sufficiently early (Graham and Harner 1988, Whalen 1991).

Because bank failures severely strain depositors’ resources and undermine investor confidence, predicting failure and problem banks early can help regulators minimize the bailout costs, and when possible, avoid closing banks. The study of “early warning models“ is important for at least two reasons. First, a greater understanding of the factors that contributes to the failure enable auditors and bank examiners to identify and report problems early. This can facilitate management to take corrective actions before it is too late. Second,
regulators can intervene early into the affairs of problem banks so that mitigating actions can be taken to reduce the expected costs of failure. Two main approaches in bankruptcy prediction studies can be distinguished: The first and most often used approach has been the empirical search for predictors (financial ratios) that lead to lowest misclassification rates. The second approach has concentrated on the search for statistical methods that would also lead to improved prediction accuracy.

The early studies of failure prediction were concerned only with simple analysis of financial ratios (Fitzpatrick, 1932), the advanced statistical methods or computers were not available for researchers. The majority of the studies have focused on enhancing the statistical methodology and/or expanding the set of explanatory variables with the goal of improving prediction accuracy (Jones, 1987). The theoretical and empirical literature has identified a vast array of variables potentially associated with banking crises (see Kaminsky and Reinhart, 1999; Demiruc-Kunt and Detragiache, 1998; Glick and Hutchison, 1999). With some exceptions, this literature has relied on accounting-based measures. More recent studies have used proxies for the probability of bankruptcy (PB) as an independent variable in their studies, rather than as the dependent variable. These later studies have used the existing bankruptcy literature to obtain PB proxies, and hence, have relied on accounting based-measures. Many of these studies have used composite measures that statistically combine several different accounting variables, with Altman’s (1968) Z-score and an O-Score derived from Ohlson’s (1980) models being the most popular. The option-pricing literature provides a natural starting point.
Based on the approach developed by Black and Scholes (1973) and Merton (1974) (BSM), equity can be viewed as a call option on the value of a firm’s assets. When the asset value falls below the face value of liabilities (i.e. the strike price), the call option is not exercised and the firm is turned over to its debt holders. While traditional BSM-type models imply no role for accounting information, two recent studies (Core and Schrand, 1999, and Duffie and Lando, 2001) suggest that accounting information can be incrementally informative, even when markets are efficient. This incremental role arises under several conditions:

(i) When the market cannot perfectly observe the firm’s true underlying asset value;

(ii) When financial statements imperfectly measure asset values, and/or

(iii) Debtors can force bankruptcy only after an accounting-based debt covenant has been violated.

3-2 The Prediction variables:

The studies cited above consider bankruptcy as a change in the financial status appropriately reflected through financial ratios. Many early warning models have been proposed for examining the financial viability of banks based on the financial ratios of those institutions. They include multivariate discriminant analysis (MDA) (Stuhr and Vanwicklen 1974, Sinkey 1975, 1978, 1980), factors analysis and logit regression (West 1985, Gajewski 1989), event – history analysis (Looney et al. 1989), market data analysis (Demirguc-Kent 1989, Thompson 1991), proportional hazard model (Whalen 1991), and belief networks (Sakar et al.)

Most of these models have focused on identifying relevant variables important in predicting financial distress and in testing the classification accuracy of the models. A few studies have focused on the likely time failure as part of the prediction model and the classification errors in prediction (Looney et al. 1989, Whalen 1991).

All of these studies contributed to an understanding of the factors that affect problem banks.

Recent studies on banking differs noticeably from previous work in placing considerable emphasis on formal analysis in place of the informal, discursive treatments that are to be found in the traditional literature. Earlier treatments never developed a theory of banking instability or even a satisfactory explanation of why banks exist or
fail, and formal attempts to model banking instability only began within the last decade.

There are three basic techniques for the selection of the distress variables: Discriminant analysis, logit analysis, and genetic algorithms. They have different assumptions concerning the relationship between the independent variables.

(1) Linear Discriminant Analysis: is based on linear combination of two or more independent variables that will discriminate between a priori defined groups, which in our case are distressed and healthy commercial banks. This is achieved by the statistical decision rule of maximizing between-group variance relative to the within-group variance. The discriminant analysis derives the linear combinations from an equation that takes the following form:

\[ Z = \Sigma WnXn \]

Where: \( Z \): Discriminant score,

Be a linear combination of \( Xn \) is the independent variables that can be: \( X1, X2, X3, \ldots, Xn \) as financial ratios able to discriminate healthy from distressed banks,

And \( Wn \): \( W1, W2, W3, \ldots, Wn \) are the discriminant weights, values or coefficients of ratios determined by means of past data and some criterion that makes \( Z \) useful as an index for discriminating among the two groups. Thus, each bank receives a single composite discriminant score, which is then compared to a cut-off value, which determines the group to which the bank belongs.

The two most frequently used methods in deriving the discriminant models have been the simultaneous (direct) method and the stepwise method. The former is based on model construction, i.e. the model is
defined and then used in discriminant analysis. When the stepwise method is applied, the procedure selects a subset of variables to produce a good discriminant model using forward selection, backward elimination, or stepwise selection. The stepwise begins with no variables in the model. At each step, the variable that contributes least to the discriminatory power of the model measured by Wilks’ Lambda fails to meet the criterion to stay, it will be removed.

(2) Logit Analysis: uses the logistic cumulative probability function. Logistic regression analysis has been used to investigate the relationship between binary or ordinal response probability and explanatory variables. It fits the logistic regression by the method of maximum likelihood. This technique does not assume multivariate normality and an equal covariance matrix as discriminant analysis does. It incorporates nonlinear effects and uses predictive cumulative function in predicting distress. Among the first users of logit analysis in the context of financial distress was Ohlson (1980). Like discriminant analysis, this technique weights the independent variables and assigns a Z score in a form of failure probability to each company in a sample. Ohlson model applied a representative sample for 105 bankrupt and 2058 non-bankrupt firms. Using the chi-squared statistic, the significant variable will enter the model. This technique uses cumulative function in predicting bankruptcy. He stated that predictive power appears to be less than reported in previous studies. The logit analysis was only applied for companies and not for banks. One can criticize its application in the banking sector as it incorporates nonlinear effects. Also there is a probability of failure or success only in this technique.
(3) Genetic algorithm is a global procedure based on the mechanics of natural selection and natural genetics. In this technique, if an optimal selection was to be made out of N variables we used bit strings of length N, a one at position (A) meant that variable (A) was used in the network.

Banks are financial intermediaries whose liabilities are mainly short-term deposits and whose assets are usually short and long-term loans to business and consumers. When the value of their assets falls short of the value of their liabilities, banks become insolvent. The value of bank’s assets may drop because borrowers become unable or unwilling to service their debt (credit risk). Credit risk can be reduced in various ways, such as screening loan applicants, diversifying the loan portfolio by lending to borrowers who are subject to different risk factors, or asking for collateral. The theory predicts that shocks that adversely affect the economic performance of bank borrowers and cannot be diversified should be positively correlated with systematic banking crises. Furthermore, for given shocks banking systems that are less capitalized should be more vulnerable. The empirical literature has highlighted a number of economic shocks associated with episodes of banking sector problems. Gorton (1998), mentioned: cyclical output downturns, terms of trade deteriorations, declines in assets prices, and inadequate capital.

If we assume that both micro- (bank specific) and macroeconomic influences can lead to banking distress and crises, how can we predict their impact systematically? One way is to view bank distress as being influenced by:
• **Market risk**: It is the risk that market conditions will change the value of underlying assets. Banks are subject to high market risk when their investment portfolios are concentrated in sectors strongly affected by cyclical economic conditions, sectors where returns are significantly higher than market levels, booming sectors prone to be depressed by a subsequent bust, or various sectors that adversely similarly affected by economic shocks.

• **Default or credit risk**: It is the risk that debtors will be unwilling or unable (perhaps as a result of changed economic conditions) to repay their debts.

• **Liquidity risk**: in the case of bank crises, liquidity risk is the risk that depositors will withdraw their deposits in large amounts or that bank will not have enough liquid assets to cover these withdrawals.

Kunt and Detragiache (1998) argue that “the degree of exposure to these risks that individual bank’s management decide to assume depends on their risk preferences, given the expected future returns associated with their portfolio strategies, and regulatory guidelines”. The best way for the measurement of these risks is through the elements of the financial statements.

Even in the absence of an increase in non-performing loans, bank balance sheets can deteriorate if the rate of return on bank assets falls short of the rate that must be paid on liabilities. Perhaps the most common example of this type of problem is an increase in short-term interest rates that forces banks to increase the interest paid to
depositors. Another case of rate of return mismatch occurs when banks borrow in foreign currency and lend in domestic currency, or vice-versa. In this case, an unexpected depreciation of the domestic currency threatens bank profitability. Many countries have regulations limiting banks’ open currency positions, but sometimes such regulations can be circumvented (Garber, 1996).

The current literature on the subject is largely divided into three kinds of studies;

- Those that examine data on specific banks (analysis of their financial statements) in an effort to explain why they are facing such distress,

- Those that examine how changes in various macroeconomic variables (such as interest rate changes, inflation, changes in exchange rates) have contributed to banking crises, in addition to the regulatory variables imposed by the central bank or the stock market, if it is an efficient one. The macroeconomic variables are very important when banks are evaluated under different economic conditions (i.e. in different countries); they have minor effects when the economic components are similar,

- Those that examine the microeconomic variables of a specific bank or group of banks. (Altman, 2000). If we assume that the microeconomic (or bank-specific) influences can lead to banking distress, how can their impacts be measured systematically? The main measurement is through the components of the published
financial statements. These financial statements will help us to measure the degree of risk (default risk, and liquidity risk), the adequate capital, earnings movements, the quality of assets and even of liabilities, and also the quality of management.

In this study, we concentrate on the first and last type of studies, in addition to the effect of the regulatory factors of the second class, as it may affects banks differently. Many models in the literature followed the same concepts; they differ in the selection of the variables. Some of these models were found to be successful in their internal environment, while some were internationally applicable. Certain models were used for specific types of organizations because of the nature of their selected variables, and some were generally useful. In this manner, some of the important models may be highlighted.
3-3 Distress Prediction Models:

The study of Beaver (1966) is considered the pioneering work on bankruptcy prediction models. Beaver motivated his model by a framework quite similar to the model of the gamblers ruin *. The firm is viewed as a reservoir of liquid assets, which is applied by inflows and drained by outflows.

The solvency of the firm can be defined in terms of the probability that the reservoir will be exhausted, at which point the firm will be unable to pay its obligations as they matures. Beaver state four propositions:

- The larger the reservoir, the smaller the probability of failure.
- The large the net liquid assets, the smaller the probability of failure.
- The larger the amount of debt held, the greater the probability of failure.
- The larger the fund expenditures for operations, the greater the probability of failure.

Beaver identified 30 ratios that were expected to capture relevant aspects. By univariate discriminant analysis, these ratios were applied on 79 pairs of bankruptcy / non-bankruptcy firms. The best discriminators were: Working capital funds
flow / Total assets, and Net income / Total assets, which correctly identified 90% and 88% of the cases.

*In the gamblers ruin model one assumes that net assets follows a random walk process with some fixed probability of a negative cash flow each period.

The Beaver model can be criticized in the sense that:

- It requires a large number of firms with similar sizes and under the same financial periods.
- It is not important that larger debt will lead to failure and not also large expenditures.
- The model compares only between success and failed firms.
- The model was only relevant to the manufacturing companies.
- Some single ratios were examined against benchmarks, which are not practical in different economies or industries.

3-4 The CAMEL Variables:

In the USA, when examiners evaluate a bank’s wealth, they develop an overall rating based on Capital adequacy, Asset quality, Management quality, Earning ability and Liquidity position – hence the term CAMEL rating. Federal regulators developed the numerical CAMEL rating system in the early 1970s to help structure their examination process. Since then, the use of CAMEL factors has become widespread, due to its simplicity and use by regulators.
Financial data and relationships are the principal ingredients for scoring capital, asset quality, earnings and liquidity. Assessing management quality, however, is more difficult; it typically requires professional judgment of bank’s compliance to policies and procedures, aptitude for risk taking, development of strategic plans, and the degree of involvement by the banks’ officers and directors in making decisions.

The prominent three models that use CAMEL in the literature are:

1) Martin (1977): The variables of this model are: Net income / Total assets, Expenses / net operating income, Commercial and industrial loans / Total loans, and Gross capital / risk assets. The coefficients were: -120.86, 2.2, 7.89, -35.63, and a coefficient of – 5.33. The cut-off points are 3.448 and – 2.351.

2) Pantalone and Platt (1987): The variables generated by this model are: -71.39 Net income / Total assets, -11.79 Equity capital / Total assets, 7.71 Total loans / Total assets, 3.72 Commercial and industrial loans / Total loans, 10% change in residential construction, and a constant of – 0.10. The model applied to 226 survived banks and 113 failed banks and the cut-off points are: 2.35 and – 56.25.

3) Bar, Sieford and Siem BSS (1993): It is a recent model using CAMEL, the variables generated by the model are: 5.1395 Constant, - 9.6993 Equity capital / Total loans,
DAE Efficiency score (-7.7682), 17.8065 Non-performing loans / Total assets, -22.0646 Net income / Total assets, 5.8907 Large deposits / Total assets, and – 2.7024 Construction. The model correctly classified 92.1% of successful banks and 82.9% failed banks in the sample.

Most distress prediction models include variables that can be categorized under four of the five CAMEL factors; the variable that is usually missing in the quantitative analysis is the management quality. As Seballos and Thompson (1990) state “the ultimate determinant of whether or not a bank fails is the ability of its management to operate the institution efficiency and to evaluate and manage risk”. Yet few researchers have attempted to quantify management quality or incorporate realistic surrogates for management performance in predictive models.

To assess bank’s management quality, we have to view a bank as processing multiple inputs to produce multiple outputs, and focuses on its key financial intermediation functions of acquiring deposits and making loans and investments. Using Data Evolvement Analysis (DEA), a management quality metric is established that is designed as a proxy for the ‘M’ in the CAMEL rating. DEA scores for surviving institutions are statistically higher than the scores of failed banks; these will evidence that the quality of management is crucial to a bank’s survival.

Clearly, the quality of a bank’s management is critical to its long-term survival. But does it require an on-site inspection? Barr, Seiford, and Seims (BSS) (1993) develop a methodology for
quantifying a bank’s managerial quality using only publicly available financial information. Their model captures the efficiency of bank management with a transformational efficiency model described by six inputs and three outputs. The model uses (DEA) to gauge a bank’s performance relative to others. Their study’s finding was: From 1984 to 1987 the average DEA scores for a sample of surviving banks ranged between 0.8142 and 0.8315; whereas, for failed banks the average scores dropped from 0.7986 to 0.6694.

DEA is a non–parametric estimation method, which involves the application of mathematical programming to observed data to locate a frontier, which can then be used to evaluate the efficiency of each of the organizational units responsible for the observed output and input quantities. DEA has proven particularly a dept at uncovering relationships that remain hidden for other methodologies (Refer to Ali and Seiford 1992).

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1- Full-time Employee</td>
<td>1-core deposits</td>
</tr>
<tr>
<td>2- Salary expenses</td>
<td>2-Earning assets</td>
</tr>
<tr>
<td>3- Premises and fixed assets</td>
<td>3-Total interest</td>
</tr>
<tr>
<td>4- other non- interest expenses</td>
<td></td>
</tr>
<tr>
<td>5- Total interest expenses</td>
<td></td>
</tr>
<tr>
<td>6- Purchased funds</td>
<td></td>
</tr>
</tbody>
</table>

_Bank Management_

**Figure (3-1) Bank management quality model**

BSS assumes a bank as a transformer of the six inputs into the three outputs. Seims (1992): “Bank managers should be efficient in;
managing the money position, providing liquidity, lending profitably, and investing rationally into a practical asset/liability management framework. The most efficient banks do this by controlling operating expenses, managing interest rate sensitivity, utilizing risk management techniques, and strategically planning for the bank and its future markets.

During the mid 1980s, the FDIC developed a surveillance system known as CAEL, which is a methodology similar to CAMEL (BSS). The CAEL evaluates only four factors; capital adequacy, asset quality, Earnings and liquidity. The system does not provide management rating. It is based on the bank call report data; but whereas CAMEL calculated a composite percentile ranking, CAEL calculates off-site surrogates for CAMEL ratings.

The CAEL calculation is more complex and involves many financial ratios. Like the (BSS) system the CAEL divides banks into peer groups based upon asset size and calculates percentile ranking for four sets of financial ratios that correspond to the four component ratings. The CAEL composite rating is calculated as a weighted average of the four-component rating. CAMEL and CAEL methods use a set of financial ratios to calculate a composite score with which bank regulators can assess the financial condition of a commercial bank. The macroeconomic factors can be considered as external factors, while the microeconomic as internal factors that affect the banking distress.

To measure the score of these variables, different financial ratios can be applied to measure directly some variables and indirectly other ones. CAMEL and CAEL are useful tools in the prediction of banking
distress and failure, although they failed to provide accurate quantitative measure for the management factor.

3-5 The Diamond – Dybvig (DD) Model (1983):

A key paper in the new literature is: Diamond and Dybvig (DD)(1983), which sets out an analytical framework that has since become more or less standard. DD attempt to explain why banks are subject to potentially damaging runs, and what the government could do to protect them. One can view much of the rest of the literature as attempting to sort out the issues raised by their work. Two general issues dominate the literature – why is there banking instability, and as a subsidiary question, why is it damaging? And what if anything, should the government or the banking authorities do about it?

DD suggest that banking instability arises because depositors’ liquidity demands are uncertain and banks’ assets are less liquid than their liabilities, and they suggest that banking instability is harmful because it ruins risk-sharing arrangements and damages production. They also argue that this instability creates a need for government deposit insurance or a lender of last resort to provide emergency loans
to banks. Later literature in the DD traditions develops these answers further and has been used to justify additional policies (Anderlini, 1986; Smith 1984; Freeman, 1988).

This model is based on the following assumptions:

- The liquidity problem is the main source of banking failure, specifically, if the depositors’ demand for liquidity is uncertain and the banks’ assets are less liquid than their liabilities.
- The investment portfolio of the bank is profitable to investors and provides reasonable returns to the investment deposits, otherwise the investor will withdrew and reduce the financial profitability and liquidity of the bank.
- The banking instability is a function of depositors’ behavior and the period of time at which bankruptcy will occur.

Criticisms to the DD - Model:

- It is classifying firms into failed and non-failed only, while our objective is only the financial distress.
- It is more relevant to the trading and manufacturing companies rather than to the service sector or banks.
- The model is basically, concentrating on the period of failure, rather than the factors influencing that failure.
- The model is not obviously a prediction model. It is concerned with the determinants of instability and
restricted the determinants factors into only two financial factors (liquidity and withdraw of deposits), so it is not suitable to our study.

3-6 The Hazard Model:

(Tyler Shumway 2001) developed a hazard model that is more consistent and unbiased. Estimating hazard models with the accounting variables are used previously by Altman (1968) and Zwijweski (1984). This new model uses three market-driven variables to identify failing firms. The Hazard model assumes that bank failure can be in general considered as an event that involves two outcomes: failure and non-failure. The model can estimate the probability of occurrence of an event by the dichotomous random dependent variable that takes two discrete values: $Y_i = 1$ if the bank is classified as a failed bank, and $Y_i = 0$ otherwise and each bank has critical cut-off point.
To estimate a hazard model with a logit program, each year in which
the bank survives is included in the sample as a bank is healthy.
The hazard model is estimated with several different sets of
independent variables. The Hazard model in USA exploits all
available data from 1962 to 1992 for 2496 firms of which 229 were
completely failed firms. The hazard variables and their coefficients
were as follows: **Table (3-1) Hazard Coefficients**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-3.226</td>
</tr>
<tr>
<td>Working capital / Total assets</td>
<td>-0.732</td>
</tr>
<tr>
<td>Retained Earnings / Total assets</td>
<td>-0.818</td>
</tr>
<tr>
<td>EBIT / Total assets</td>
<td>-8.946</td>
</tr>
<tr>
<td>Market Equity / Total Liabilities</td>
<td>-1.712</td>
</tr>
<tr>
<td>Sales / Total assets</td>
<td>0.158</td>
</tr>
</tbody>
</table>

The main result was that firms with higher earnings relative to assets
are less likely to fail.
The forecasting models incorporate Altman’s (1968) and (1993) that
is of 5 variables; and Zmijewski’s (1984) independent variables, as
well as some market – driven independent variables.

Zmijewski’s variables (1984) are:

1) *NI/TA*: Net income to total assets
2) *TL/TA*: Total liabilities to total assets
3) *CA/CL*: Current assets to current liabilities

It is found that when applied on 30 firms during 1983 and 1992; firms with high income and low liabilities are less likely to fail than
other firms. The (CA/CL) ratio is not significantly related to bankruptcy in any of the estimates. While according to Zmijewski’s model both NI/TA & TL/TA are excellent bankruptcy predictors, according to the hazard model, only the coefficient of NI/TA is significantly different from zero at 99% level. This fact combined with the fact that TL/TA and NI/TA are strongly correlated (p=.4), suggests that zmijewski’s model is essentially a one variable model.

Still the variables in Altman’s and Zmijewski’s models measure similar things. Both EBIT/TA & TL/TA measure the profitability of the firm, while both ME/TL & TL/TA measure the firm’s leverage. In addition to these variables the hazard model incorporates other market–driven variables. It uses 2 panels: Panel A: Market variables only (relative size, the last difference between market returns and firm’s returns i.e. deviation $rt-1 - rmt-1$, and sigma). Two accounting variables are added in panel B to the market variables (NI/TA & TL/TA).

Tyler Shumway stated that: “I find that half of the accounting ratios used previously are poor predictions, several previously neglected market-driven variables are strongly related to bankruptcy probability “. A firm’s market size, its past stock returns ($rt-1$, $rmt-1$), and the idiosyncratic standard deviation of its stock returns all forecast failure.

Advantages of the hazard model:

- It resolves the problem of static range of time.
- The firm’s risk for bankruptcy changes through time.
- It controls for each firm’s period at risk, because some firms fail in the first year of risk, while others remain for years.
• It incorporates macroeconomic variables.
• It utilizes much more data.
• Hazard models often produce dramatically different statistical inferences than do static models.
• The hazard model assumes that bankruptcy can only occur at discrete points in time, \( t = 1,2,3 \), Most bankruptcy samples contain data on \( n \) firms that all existed for sometime between \( t=1 \) and \( t=T \). Each firm either fails during the sample period, or survives during the sample period, or it leaves for some other reason such as a merger or liquidation. Define a “failure” time, \( t_i \) for each firm (i) as the time when the firm leaves the sample for any reason.

We cannot apply the hazard model to our study because of the following limitations:

• The model assumes only failed firms, which are out of business and non-failed that are surviving. Sometimes distressed or failed firms may continue in the business.
• It depends on discrete value for the situation of failure or not at a specified period of time. Also survival or failure time is limited; this is not true in real life.
• The model applies controls for the firm’s period at risk, which may not be really practiced.
• In practice, however, many hazard models are difficult to estimate because of their nonlinear likelihood functions and time varying covariates.
• The test statistics produced by a logit program are incorrect for the hazard model because they assume that the number of independent observations used to estimate the model is the number of firm years in the data.

3-6 Neural Networks

Statistical modeling plays an important role in accounting research. This model is concerned with the application of neural networks (connectionist models) in accounting research in the light of recent claims that such methodologies can outperform traditional statistical approaches. The majority of neural network studies in the business area to date have been financial forecasting applications. Baestaens et al., 1994 used it for the modeling of arbitrage pricing theory, Kryzanowski et al. and Yoon et al. (1993)”The prediction of stock price performance, Trippi and Turban (1993), Coast and Fant (1993) apply it to the going concern qualification decision, Singleton
and Surkan (1995) in credit scoring and bond rating, Coakly and Brown (1993), prediction of merger. In addition, much of this work appears in non-accounting and non-finance journals, is undertaken by computer scientist and engineers and is in case study form (Hill et al., 1994).

Neural networks were originally developed to deal with problems of an artificial intelligence such as speech, text and other pattern-recognition tasks, which conventionally computing approaches were unable to solve. More recently, connectionist models have been also applied in such areas as defense and medicine.

There are many types of neural network; we focus here on the technique principally used in the prediction of failure. The NN model was applied by Koh (1991) using the WinNN software for 330 randomly selected observations. The model comprises 6 input nodes (i.e. six financial ratios) in the input layer, 13 hidden sub-ratios in the hidden layer, and the output node that is the occurrence of failure. (See the figure). All levels are interacting and depend on each other’s. The result indicates 100% accuracy at a cut-off level of 0.5 in the output to signify failure.

It is difficult to apply this model in our study because:

- The model requires a lot of data in different stages or layers of the model, which may not be easily available.
- It takes into consideration the individual firm and not a group of firms, so it is not suitable for this study.
- Such models are more efficient in the conceptual tests; like language.
A test by Altman indicates that there is no great difference in results between the neural networks and the multiple discriminant analysis in the prediction of failure.

**Figure 1:** A neural network – Each node represents a separate Generalized Linear Function.

Output

Hidden Layer

Inputs
\begin{figure}
\centering
\begin{tabular}{ccccccc}
X1 & X2 & X3 & X4 & X5 & X6  \\
\end{tabular}
\caption{The Neural Network}
\end{figure}

Where: 
X1: Quick assets to current liabilities
X2: Market value of equity to total assets
X3: Total liabilities to total assets
X4: Interest payments to earning before interest and tax
X5: Net income to total assets
X6: Retained Earnings to total assets

Hidden Layers are 13 hidden or sub-ratios

Output: is the status of failure or success.

\section*{3-7 Bayesian Models:}
Bayes’ Theorem, was published in the eighteenth century by Reverend Thomas Bays, says that you can use conditional probability to make predictions in reverse, so it is sometimes called Inverse Probability Law. It is an example of what we call statistical inference. Bayes’ Theorem is used to solve for the inverse conditional probability. For Bayesian model: 
\[ P(A/B) = \frac{P(B/A)P(A)}{P(B)} \]

Probabilistic Models for predicting bank failures (Sarkar and Sriram 2001) examined the role of probabilistic models for providing calculus as a measure of uncertainty because of its strong theoretical basis and empirical testability.
(Asave and Messier1991), demonstrated the Bayesian belief revision model, but they found it inconsistent with the auditors’ believes. They stated that the probability estimates are both sharp and well calibrated. Sharpness refers to the ability of a model to strongly discriminate across healthy and distressed firms. Probability estimates are well calibrated if they closely approximate the true underlying uncertainty. They use two distinct probabilistic models; the first is a simple Bays model that assumes independence of all the predictive attributes (ratios) conditioned on the outcome variable. The second model uses a partitioning of the attributes based on the interaction of the different financial ratios being used for prediction.

*The definition of conditional probability is:*
\[ P(B/A) = P(A \text{ and } B)/P(B), \quad (1) \]
\[ P(A/B) = P(A \text{ and } B) /P(B), \quad (2) \]
Solving (1) for \( P(A \text{ and } B) \) and substituting into (2) gives Bayes’ Theorem.

The probabilistic model examines the historical cases to arrive at probability estimates regarding the likelihood of different feasible outcomes (i.e. financially sound or financially distressed). Financial ratios of each bank are treated as discrete variables; they are dependent on the outcome state.

Experimentally, the financial ratios applied in this model are 51 ratios for three-year period, 1986-1988 (i.e., there were a total of 153 financial ratios that could be used as predictors) for predicting a bank’s financial health. The ratios reflect the bank’s performance in four important areas: asset quality, overhead risk, earnings risk, and capital adequacy. The values of ratios are converted into two
categories, “Above average” and “Below average”. The randomly selected banks were 228 out of 911 different banks. The model correctly classified healthy banks with 92% degree of accuracy.

Limitations of the Bayesian Model:

1) When there is large number of predicting attributes, it will be difficult to get an accurate result.
2) The model depends on the number of ratios subject to test in the financial period.
3) The outcome should be known in advance.
4) It includes only part of the financial ratios (liquidity and risk ratios only) & ignores other factors.
5) The model provides only discrete results for healthy bank, (above or below average).

The variables of some bank failure prediction models can be summarized below:

<table>
<thead>
<tr>
<th>Source</th>
<th>Variables</th>
<th>Coefficients</th>
<th>Survived banks</th>
<th>Failed Banks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Martin (1977)</td>
<td>Constant</td>
<td>-5.33</td>
<td>5642</td>
<td>58</td>
</tr>
<tr>
<td></td>
<td>NI /TA</td>
<td>-120.86</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gross Exp. / Op.Inc</td>
<td>2.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Comm. L / T. Loans</td>
<td>7.89</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gross Cap. / Risk</td>
<td>-35.63</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Assets</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------------------------</td>
<td>-----------------------------</td>
<td>------------------</td>
<td>------</td>
<td>----</td>
</tr>
<tr>
<td>Hartweek (1997)</td>
<td>Constant</td>
<td>-4.14</td>
<td>177</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>NI / TA</td>
<td>-69.49</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>EQ / TA</td>
<td>14.86</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Op.Inc / TA</td>
<td>-0.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Loan / Cap.</td>
<td>0.26</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>%Change. TA</td>
<td>-1.18</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Size Log(A)</td>
<td>0.02</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pantalone &amp; Platt (1987)</td>
<td>Constant</td>
<td>-0.01</td>
<td>226</td>
<td>113</td>
</tr>
<tr>
<td></td>
<td>Com. L/TL</td>
<td>3.72</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>NI / TA</td>
<td>-71.39</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>EQ / TA</td>
<td>-11.79</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Loan /TA</td>
<td>7.71</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**CHAPTER FOUR**
THE STRUCTURE OF BANKING CAPITAL

CHAPTER FOUR [PART (A)]
Banking Regulations & Capital Adequacy

The chapter is concerned with the role of capital in commercial banks, adequacy of banking capital, how capital is regulated, and who are the regulators of banking capital.
Here we need to know why banks are regulated, what type of regulation, and who regulate banks? Regulations are most likely to benefit savers, borrowers, and the economy in the long run. The health of financial institutions has focused on liquidity risk associated with unanticipated withdrawals of deposits and information problems. Banks hold reserves as a cushion against anticipated and unanticipated withdrawals by savers. Savers, however, cannot know the true health of the bank because it has private information about its loan portfolio. Because banks have private information, depositors may lose confidence in even financial healthy of banks. When enough savers lose confidence in a bank’s portfolio of assets, a bank run can occur.

To understand how banking regulations come about and how they affect the banking industry, its competitors, and savers and borrowers, we need to consider regulatory intervention as a process. In this process a financial crisis prompts the government to enact legislation and impose regulation. The cycle of crisis contains four parts:

1) Financial crisis: This part of the cycle is caused by the savers’ loss of confidence in bank’s ability to use their funds wisely. When savers lose confidence in them, banks are unable to fulfill their role as intermediaries for many borrowers. Adverse selection and moral hazard problems have the potential to create instability, which can lead to such crises in the financial system.

2) Regulation: The government generally intervenes when it perceives instability in financial institutions and when political pressures make intervention advisable.
3) Financial innovation: It is the response of the financial system as a result of regulatory intervention and deposit insurance.

4) Regulatory response: This is the fourth part of the cycle that occurs as regulators observe the impact of regulation on changes in the way that financial institutions do business.

4-1-A The role of capital:
The point of departure for all modern research on capital structure is the Modigliani and Miller (M&M) (1958) preposition that in a frictionless world of full information and completes markets; a firm’s capital structure cannot affect its value. This preposition contrasts sharply with the intuitive notion that a firm with risk-free debt could borrow at an interest rate below the required return on equity, reducing its weighted average cost of financing and increasing its value by substituting debt for equity. Financial institutions lack any plausible rationale in the frictionless world of M&M. Most of the past research on financial institutions has begun with a set of assumed imperfections, such as taxes, costs of financial distress, transactions costs, asymmetric information, and especially regulation. Nonetheless, as Miller (1995) argues below, these imperfections may not be important enough to overturn the M&M preposition. In contrast, most of the other papers in this issue take the view that deviation from M&M’s frictionless world is important, so that financial institutions may be able to enhance their market values by taking on an “optimal” amount of leverage.
The bank capital plays an important role for all operational activities of the bank. Capital provides the financial cushion for economic losses, protecting depositors, other creditors and financial institutions, which are often forced to absorb bank losses in the interest of maintaining banking system stability. As traditionally measured, equity capital is the difference between assets and liabilities. However, broader measures of capital generally include reserves against loan losses-which, in theory, should equal the expected level of losses imbedded in the existing asset portfolio-and certain forms of long term debt that may provide additional capital support to depositors and any deposit insurance program. Cantor (2001), states “because losses are normally incurred gradually over time, the creditors’ first line of defense comes from bank operating earnings”. If it were practical, an ideal measure of capital would include a valuation of each bank’s risk-adjusted expected future profit stream, particularly an assessment of sustainable profits in the advent of a severe asset quality problem. A key statistic in formulating capital requirements is the capital ratio, that is, the ratio of capital to total assets. A typical measure of capital is equity, possibly increased by the level of subordinated debt; Berger, Herring, and Szego (1995), find that several sharp drops in capital ratios follow major changes in the regulatory framework.

**4-2-A: Capital Adequacy:**

Most work on the subject of capital structure concentrates on the structure of industrial firms. But bank assets and functions are not the same as those of industrial firms. In fact, one strand of the banking
literature suggests banks have a role precisely because they do not suffer the asymmetric information costs of issuance faced by industrial firms (Gorton and Pennacchi, 1990). Bank’s capital structure affects its liquidity creation and credit creation functions in addition to its stability. The consequent trade-offs imply an optimal capital structure. Because customers rely to different extents on liquidity and credit, bank capital structure also determines the nature of the bank’s clients. The optimal capital structure for a bank trades off three effects of capital – more capital increases the rent absorbed by the banker, increases the buffer against shocks, and changes the amount that can be extracted from borrowers.

Over the past several years, there has been an extensive discussion among practitioners and academics about whether and how a portfolio management approach could help banks to better manage risk capital and create shareholder value. Capital requirements play a major role in the banking industry (Berger, Herring, and Szego; 1995). Following Estrella (1995), we can distinguish between market capital requirements and regulatory capital requirements. A bank’s market capital requirement defined by Berger as: “the capital ratio that maximizes the value of the bank in the absence of regulatory capital requirements but in the presence of the rest of the regulatory structure that protects the safety and soundness of banks”. Market capital requirements serve to reduce agency problems, balance the benefits of tax evasion versus increases in financial distress costs, and reduce transaction costs if new investment capital is needed. Banks, however, differ substantially from most other firms because they are protected by a regulatory safety net, this protection from bankruptcy and the
costs of financial distress will affect market capital requirements. The safety net refers to all government actions designed to enhance the safety and soundness of the banking system other than the regulation and enforcement of capital requirements. Regulatory capital requirements, by contrast, aim at protecting the government (and ultimately the taxpayers) against financial distress costs and guaranteeing the soundness and stability of the financial system. From this regulatory or supervisory perspective, capital serves as a cushion to absorb part of the effect of adverse economic development on financial institutions.

Currently, the regulatory capital approach is in the course of revision, and to use it does not make much sense to report in detail on the current state of discussion.

In 1983 the banking supervision authorities of the main industrialized countries (G7) agreed on rules for banking regulation, which should be incorporated into national regulation laws. Since the national regulators discussed these issues, hosted and promoted by the Bank of International Settlement located in Basel in Switzerland, these rules were called The Basel Capital Accord.

The Basle Committee within the Bank of International Settlements (BIS) released in January 2001 a proposal for reforming the original 1988 Accord. In fact since 1988 international banks need to hold at least 8% capital against their risky assets. Under the 8% rule, banks have to prove that the capital they hold is larger than 8% of their so-called Risk Weighted Assets (RWA), calculated for balance sheet positions. This rule implied that the capital basis for banks was mainly driven by the exposure of the lending to their customers. Even though
the ratio was deeply negotiated, the banking community has complained since the beginning about the lack of rationale behind the capital requirement regulation. In particular the definition of different categories of risk appeared arbitrary and inappropriate since it relied solely on the creditworthiness of the debtor: risk assessment is a far more complex process than this, integrating many and various other factors. This gap between the regulatory approach to risk and the business practice leads in some cases to “regulatory arbitrage”, which goes against the initial goal of the regulation. After 14 years the 8% capital requirement progressively became the yardstick for any bank, internationally or not. At the same time the Basle committee authorized the banks to use their internal model of risk assessment as an additional instrument to compensate for the regulation’s lack of accuracy.

In June 1999, the Bank for International Settlements (BIS) Committee on Banking Supervision issued its consultative paper on “A New Capital Adequacy Framework”. This report was based on collaborative work of representatives from twelve of the world’s central banks and seeks to replace the outdated “Basel Accord of 1988”, which has been the guideline for capital reserves that banks allocate against possible losses from loans to sovereign governments, other banks and corporations.

The Basle Committee re-examined the capital regulation with a view to its improvement. For that reason the Committee released in January (2001) a new proposal (Basle 11) to the international banking community, inviting their comments. The three pillars of this new proposal (to be implemented by 2005) are the following: The first one
describes the rules for determination of bank’s required capital, intended to cover unexpected credit losses. The second pillar concerns the supervisory review process of the bank internal procedures for capital determination with respect to risk profile. Here, the regulated banks will have the choice between the Accord and their own internal model after approval by the Basle Committee. In the third pillar banks are asked to improve their information disclosure process that is crucial for the risk assessment of their activities. This is to increase the transparency of bank’s risk profiles for market participants through disclosure requirements.

Although the BIS framework stresses the importance of supervisory review and market discipline, the main pillar of its recommendations is the revision of minimum regulatory capital requirements. The cornerstone of these requirements is the reliance on external credit ratings, and possibly internal rating systems, to determine new risk weights of different quality asset exposures to various types of customers and investment assets.

The Basel Core principles for Effective Banking Supervision and Methodology set out the necessary foundations of a sound supervisory system. They are also crucial in preventing and dealing with distressed banks. In essence and to be effective, laws must provide for or supervisors must be given powers to set and/or require: Comprehensive rules for the licensing of banks, for permitting new major activities, acquisitions or investments by banks and for ownership changes in banks.
Prudential rules or guidelines for banks, such as norms and limits on capital, liquidity, connected lending and loan concentrations, and
powers to enforce a range of penalties when prudential requirements are not met.

1) Requirement for internal controls and risk management systems in banks are consistent with the strategy, complexity and scale of the business.

2) Requirements for effective corporate governance in banks.

3) Requirements for periodic reporting by banks and the means to conduct onsite examinations, so that problems can be detected in a timely manner.

4) Timely corrective measures to overcome difficulties.

Accounting standards based on conventions and rules that are internationally accepted and relevant for banks. In particular, there must be rules or guidance that require asset impairment to be recognized on a timely basis so that unrealizable values do not remain on a bank’s books.

There is an ongoing debate about the effects of capital adequacy rules on banks’ risk taking behavior. Blume (1999) states “If raising equity is excessively costly, the only possibility to increase equity tomorrow is to increase risk today”. Effects of capital adequacy rules on banks have been analyzed before. For value-maximizing banks, Forlong and Keeley (1989) demonstrate that capital requirements reduce risk-taking incentives, while Flannery (1989) concludes that higher risk-taking may be induced. In a mean-variance framework, Koehn and Santomero (1980, 1988), and Rochet (1992) show that: improperly chosen risk weights may increase the riskiness of banks. Other authors argue that capital requirements reduce monitoring
incentives, which reduces the quality of banks’ portfolios. (Besanko and Kanatas, 1993; Boot and Greenbaum, 1993). Finally, Gehrig (1995) points out the capital requirements influence the nature of strategic competition among banks. Jurg Blum (1999) states, “In a dynamic model with incentives for asset substitution, capital adequacy requirements may actually increase risks”. If regulators are mainly concerned about reducing the insolvency risk of banks, introducing capital rules, therefore, may not be such a good idea after all. One of the effects of such a regulation is the reduction of the bank’s profits. If future profits are low, a bank has a smaller incentive to avoid default. In addition to this, the leverage effect of capital rules raises the value of equity to the bank. While each of the above articles emphasizes a different aspect of capital adequacy requirements, they all have in common that they concentrate on static effects.

4-3-A: Why do regulators require banks to hold capital?

The difficulty in implementing a capital ratio by the Basle Committee leads to question the rationale for capital regulation. The evidence of a market failure usually justifies regulation. Capital
regulation is usually seen as a way to prevent the systematic risk associated to banks failure.

Regulators require capital for almost all the same reasons that other uninsured creditors of banks require capital; to protect themselves against the cost of financial distress, agency problems, and the reduction in market discipline caused by the safety net. Regulators respond to other externalities associated with financial intermediaries on behalf of the rest of society. This principal concern is systematic risk. The failure of large number of banks or the failure of small number of large banks could set off a chain reaction that may undermine the stability of the financial system. The problems of some banks may be transmitted rapidly to other banks since inter-bank transactions are large, variable, and difficult for outsiders to monitor (Guttentag and Herring, 1987).

The regulatory capital requirements differ substantially from market-based capital requirements. They are generally blunt standards that respond only minimally to perceived differences in risk rather than the continuous prices and quantity limits set by uninsured creditors in response to changing perception of the risk of individual banks. The limited ability to price or ration the benefit of the safety net in response to changes in bank risk may be quite costly if it permits risky banks to take advantage of the safety net by choosing lower capital ratios than the market would require them to hold in the absence of safety net.

Not all observers agree that systematic risk is an important issue (e.g. Benston and Kaufman, 1995). In the absence of systematic risk or other significant negative externalities from bank failures, the
government should behave, in principle, like a private sector uninsured creditor. The government should price risk through deposit insurance premiums and set capital standards and closure rules similar to covenants contained in standard debt contracts (Black et. al., 1978; Acharya and Dreyfus, 1989).

Despite the fact that the government is the largest uninsured creditor of banks, it does not exercise market discipline and require capital in the same way that other uninsured creditors do. Regulators do have some indirect means of pressuring banks to raise capital ratios, such as cease-and-desist orders, total withdrawal of insurance coverage, bank closure, limits on asset growth and brokered deposits, prohibition of dividends payments, etc. (Burser et al., 1981). However, these tools are blunt, uncertain, and apply only to a small percentage of institutions.

Capital regulation is motivated in part by concern over the negative externalities that may result from bank default that are not taken into account in market capital requirements. One obvious regulatory remedy would be to require banks to hold so much equity that the probability of default is negligible. The main regulatory policy goals of protecting the government’s uninsured claims on banks and guarding against the external costs of bank failure such as systematic risk suggest that instruments that qualify as regulatory capital should be: a buffer to absorb losses before government, patient money, and reduce the bank’s moral hazard.

In order to be useful, regulatory capital must be measured with reasonable accuracy. However, this is seldom a simple task. For example, equity capital is the residual claim on the bank – the value of
obligations of others to pay the bank plus the value of any other assets less the value of obligations of the bank to pay others. Therefore, measurement of equity depends on how all of a bank’s financial instruments and other assets are valued.

4-4-A: The Federal Deposit Insurance Corporation Improvement Act (FDICIA):

The nature of efficient and effective bank regulations continues to be of much concern. In developing regulations, regulators face moral hazard; agency costs, asymmetric information, and banks continue to fail throughout the world often at alarming rates. The Federal Deposit Insurance Corporation Improvement Act (FDICIA) passed by the Congress 1991. It was a new statutory framework for bank supervision that detailed early intervention and corrective action by bank regulators in dealing with troubled institutions. Specifically, section 131 of FDICIA, Prompt Corrective Action (PCA), which classifies banks into one of five groups depending on their capital ratios. The five categories defined under PCA are:

(1) Well-capitalized;
(2) Adequately capitalized;
(3) Undercapitalized;
(4) Significantly undercapitalized;
(5) Critically undercapitalized. This classification depends on three different capital ratios: (1) the total risk-based capital ratio, (2) the Tier 1 risk-based capital ratio, and (3) the Tier 1 leverage ratio.

As noted earlier, bank regulators have relied on capital ratios formally or informally for a very long time. The motivation for their
use, however, has not always been the same. For instance, in the days before explicit capital requirements, bank supervisors would use capital ratios as rules of thumb to obtain an independent gauge of the adequacy of the level of capital of an institution. There was no illusion that the simple ratios used (e.g., capital to total assets or deposits) could provide an accurate measure of the appropriate capital level for a bank, but large deviations of actual capital ratios from supervisory benchmarks were cause for further scrutiny. In some cases a ratio is intended as a minimum acceptable level, whereas in other cases there may be a desire to identify an appropriate level of capital for the bank. This distinction between a minimum and an optimum level is discussed in Estrella (1995).

An other distinction is between adequate levels and backstop levels, such as in the 1991 U.S. legislation. In one case, there is a certain level of comfort for bank supervisors, while in other case the bank is no longer considered viable. Closely related is the distinction between the value of a bank in liquidation and as a going concern. Demsetz et al. 1996, states: “The net value of a bank tends to decrease when it goes from going concern to liquidation mode”. These distinctions can be shown in the following simple graph:

![Figure (4-1) Capital Levels](image)

Figure (4-1) Capital Levels
The PCA faces some criticisms or weaknesses, such as: a number of studies have noted the inadequacy of such indicators in FDICIA, Peek and Rosengren (1996); a second problem with PCA is that it may prompt failing institutions to increase risk, and finally, increases in minimum capital standards and the imposition of other increasingly stringent restrictions by bank regulators may cause banks to increase not just their capital ratios, but may also have the unintended effect of causing them to increase their level of risk, (Sherives and Dahl, 1992). Increases in bank capital ratios and asset risk are simultaneously and positively correlated.

Declines in capital ratios have different explanations. The most common include:

- A rapid increase in risk-weighted assets;
- A reduction in the absolute amount of capital, e.g. redemption of subordinated loans;
- Overall losses in the bank operations; and
- Adverse exchange rate movements, where there is a currency mismatch between risk-weighted assets and regulatory capital.

Improving the capital position addresses the symptom. The supervisor should also seek to understand in each instance why the capital ratio fell to determine if other measures are needed. The supervisor must assess whether the bank has the financial strength and the managerial and organizational capacity to handle the new risks.

Where the bank’s capital adequacy ratio has fallen below the supervisory and/or statutory minimum, the powers of the supervisor to take formal action against the bank to restore the ratio should be
triggered. The supervisors' main consideration is whether, and how soon, the bank can restore its capital to an acceptable level. The bank should therefore be required to provide the supervisor with a clear commitment of how it proposes to restore the ratio and the timescale, with relevant milestones, for doing so.

It would be prudent for the managers to ask for assurances from the major shareholders of the bank that they continue to support the bank and are prepared to contribute to restoring the capital position by means of capital injection if the position of the bank deteriorates further. If the shareholders are unable to provide the necessary capital injection, various other options can be considered, such as: selling or securitising assets, switching the portfolio from higher to lower risk weighted assets, cutting operating costs, restricting the payment of dividends, and attracting new shareholders.

Poor management is likely to be a problem in most weak banks. While, it is not the supervisor’s role to select senior managements for banks, supervisors have the responsibility to evaluate proposed directors and senior management as to expertise and integrity (fit and proper test) and to prevent or discourage appointments deemed detrimental to the interests of depositors. Supervisors should also evaluate directors and senior managers as part of the regular supervision of the bank.

Unless there is evidence of fraud or massive incompetence – for example, if the supervisor feels that an individual is just not up to the job, as indicated by the bank’s performance – it may be difficult to request formally the removal of unsuitable persons. In such situations it may be more effective for the supervisor to discuss the future of the
management with the board of directors or the major shareholders of the bank and to seek their commitment, voluntarily, to strengthen the management. The emphasis should be on bringing in the strong individuals with the skills the bank needs.

In order to avoid distorting competition in the financial sector, small and large banks should be subject to the same supervisory and regulatory framework. This applies in normal times as well as in times of problems. There can, however, be good reasons for treating large banks differently in some explicitly defined situations. Large banks have bigger interbank linkages and carry out a wider range of activities, often including cross-border operations, and so large bank failure will create greater spillover effects. But potentially systemic problems do not arise only with large banks. They may arise when a number of small banks fail simultaneously or where a small bank has a critical position in a particular market segment. Equally the failure of a large bank may not be systemic if the economic background is very strong.

4-5-A: The Relationship between Capital Ratios and Bank Failures:

The relationship between the level of capital and subsequent failure is clear in the case of a backstop level as defined above. At this level, the bank is either a de facto failure, or is in imminent danger of
falling into that category. Therefore, regulators must choose a backstop that is highly correlated with failure in the very short run or, put differently; the level should be associated with a fairly high probability of failure. For various reasons, regulators will generally wish to select a positive level rather than the level of technical insolvency at which the net worth of the bank is zero.

One reason is that there is always some uncertainty regarding the valuation of the bank. There is no assurance that a bank that is liquidated will be valued at the accounting net worth, although this type of uncertainty could signify that the actual value of the bank could be either higher or lower than the accounting value. A second reason is that, for a going concern, there is generally a “charter value”- an intangible value that disappears with the closure of the institution. Hence, even if the accounting valuation were perfectly accurate in the first sense, the mere liquidation of the institution could lead to a loss in net value.

A capital ratio is constructed from two components. The numerator is a measure of the capital of the firm and is inversely related to the probability of failure. The denominator is a measure of the scale of the bank, and the taking of the ratio is necessary because one can only gauge whether capital is adequate in relation to some indicator of scale. At a very basic level, a large bank needs a large amount of capital than a small bank, ceteris paribus. At another level, a riskier bank needs more capital than a less risky bank.

One of the most important ratios of capital is the leverage ratio in which capital is the numerator and the denominator is the total asset of the bank. This simple measure, which has a long history, assumes
implicitly that the capital needs of a bank are directly proportional to its level of assets. A leverage ratio requirement may also affect the asset allocation of banks that are constrained by the requirement. Constrained banks are likely to reduce low risk assets such as treasury securities, which are easily marketable, as opposed to less marketable securities such as loans. Nevertheless, a clear advantage of the leverage ratio is simplicity. It is easy to calculate and fairly unambiguous. Thus, the administrative cost is low, and transparency is enhanced.

In 1988, the Basel Accord introduced the concept of risk-weighted assets as the denominator of the capital ratio. This measure contains a component representing off-balance sheet exposures and also adjusts for differentials in credit risk according to the type of counter party and the type of instrument. As such the Basel ratio represents a well-known example of a risk adjustment to the basic scale of the denominator.

The third capital ratio uses gross revenue of the bank as the measure of scale. Like total assets, gross revenue is easily obtainable from the financial statements of the firm. Unlike assets, however, gross revenue includes components associated with off-balance sheet activities. Moreover, gross revenue contains a crude risk adjustment in that riskier projects are likely to be undertaken only if they provide large revenues. Thus, gross revenue may reflect the riskiness of bank assets better than total assets, though in principal not as well as risk weighted assets.
All three ratios use tier1 capital in the numerator. The measure of tier1 capital applied in the numerator includes common stock common stock surplus, retained earnings, and preferred stock.

4-6-A: Capital Enhancement Policies:

From the data collected and analyzed, it was very clear that Sudanese Commercial Banks are facing an acute problem of inadequate capital. The bank of Sudan exerted many efforts to solve this problem through very tough regulations, and establishment of some new departments to follow up the execution of such policies.

Capital standards in Sudanese banking industry have changed with international developments in banking as well as a little bit growth in the industry assets. At the onset of entry liberalization, commercial banks were required to increase their capital to have a paid up capital amounting to $12 million for every bank. The increase in direct shareholders equity was thought necessary to get shareholders committed to the performance and survival of their banks, which could be attained through increase in their stakes. Generally, just before the deadline a good number of banks were still grossly under-capitalized. Still some banks were unable to shore up their paid up capital. It appears that greater emphasis was placed on the utilization of internally generated revenues in the attempt to shore up their capital base.

Recently, at the end of 1990s, the regulatory authorities adopted and higher capital standards following the international trend, which derived from the risk-weighted concept, recommended by the Basel
Committee (1988). The new standards attempt to relate capital to the volume of risk assets carried by a bank. In following this, a risk-weighted capital ratio of 8% is required. Within this framework risk weights are assigned to different categories of bank assets in each category and summing up. The risk weights vary between 0% and 100%. (See table 2-4).

Initially, this framework distinguishes two-tiers of capital, Tier 1 (or core) capital and Tier 2 (or supplementary) capital. Tier 1 capital refers essentially to equity capital and reserves (also known as shareholders’ funds). Tier 2 capital is made up of undisclosed reserves, revaluation reserves, and general loan loss provisions, hybrid debt capital instruments, and subordinated debts.
4-1-B: Credit Risk: An Introduction

This chapter deals basically with the literature of credit risk as one of the main hypotheses in our study and has its historical and visible effects on bank’s performance and failure. The chapter is concerned with the definition of credit risk, the measurement of risk and the models applied in this field, the management of credit risk, and finally the evaluation of management performance as an effective factor on credit risk and bank’s performance.

Financial intermediation occurs when financial institutions hold a portfolio of assets and issue their own liabilities to finance these assets. This process exposes them to risk, which if not properly managed results in failure. Depository institutions engage payments intermediation, exposes themselves to risk because most of their liabilities are liquid. Not to accept risk means not to be in the business of financial intermediation.

Banks face diverse risks such as: credit risk, liquidity risk, interest rate risk, exchange rate risk, country risk, operational risk and legal risk. Credit risk however is the commonest, first and foremost risk faced by banks. Problem loan statistics provide the most direct evidence. According to USA Central Bank report, US banks, problem loans constituted about 8% in 1994, 5% in 1995, and even 3% in 1996. While the average rates in developing countries range from 35% to 43%.

Credit risk is most simply defined by the Accord (1988) as the potential that a bank borrower or counter party will fail to meet its obligations in accordance with agreed terms.
Credit risk measurement has evolved dramatically over the last 20 years in response to a number of secular forces that have made its measurement more important than ever before. Among these forces have been:

- A worldwide structural increase in the number of bankruptcies,
- A trend towards a disinter-mediation by the highest quality and largest borrowers,
- More competitive margins on loans,
- A declining value of real assets in many markets (collateral),

Traditionally, banks have used a number of methods to measure credit risk such as: credit scoring, credit rating, credit committees…etc. At first glance, these approaches do not appear to be compatible with market risk measures. However, banks are aware of the need for parallel treatment of all measurable risks and are doing something about it.

It is probably fair to say that 20 years ago most financial institutions (FIs) relied virtually exclusively on subjective analysis or so-called banker “expert” systems to assess the credit risk on corporate loans. Essentially, bankers used information on various borrower characteristics - such as: (1) Character of the borrower, (2) capital (leverage), (3) capacity (volatility of earnings), (4) collateral,
and (5) condition (the financial condition of the borrower and the economy), the so called “5 Cs” of credit, to reach largely subjective judgment as to whether or not to grant credit. Recently the multivariate credit-scoring systems tend to outperform such experts systems (Sommerville and Taffler, 1995). Financial institutions have increasingly moved away from subjective/expert systems towards systems that are more objectively based.

In univariate accounting based credit-scoring systems, the FI decision-maker compares various key accounting ratios of potential borrowers with industry or group norms. When using multivariate models, the key accounting variables are combined and weighted to produce either a credit risk score or a probability of default measure. If the credit risk score, or probability, attains a value above a critical benchmark, a loan applicant is either rejected or subjected to increased scrutiny, (Altman and Narayanan, 1997).

4-2-B: Bank credit policy:
The biggest challenge for banks is to make profitable loans at reasonable risk. This means providing quality loans as well as a high volume of loans. Though there is no magic formula that will make loan good or bad, there are some basic principles of good lending that loan officers follow to improve the quality of loans. One method used is called “CAMPARI” which is an acronym for: Character, Ability, Margin, Purpose, Amount, Repayment and Insurance.

A bank’s credit policy must establish the broad framework of its worldwide lending activities and at the same time define day-to-day operating procedures to insure that the lending strategy and procedures are communicated and understood throughout the organization. Credit policy should strive to maximize the profitability of the lending activities within the risk constraints acceptable to the bank.

The first and most obvious risk in lending is a borrower’s inability or unwillingness to repay a loan in accordance with its terms. Management of the default risk requires the bank to understand the risk profile of its loan portfolio and to have procedures in place to identify weakening credits as quickly as possible. Portfolio management models have shown that default risk can be effectively managed and controlled by procedures that assure portfolio diversification. Lending is affected by two important risks that concern the length of time and the increased volatility of interest rates.

Development of credit policy requires a bank to assess the compatibility of its marketing and lending strategies and corporate objectives. Since the loan portfolio is the largest single asset category
in a commercial bank, it is obvious that lending strategy must be consistent with the corporate objectives. In fact, it could be argued that corporate objectives need to be developed and analyzed for reasonableness within the parameters of the bank’s lending strategy.

A bank’s credit policy is implemented on a day-to-day basis through its credit approval system. Therefore, the credit approval system must be as carefully developed as the credit policy objectives. The delegation of credit approval authority must consider:

- The experience of the lending staff
- The need to provide a timely response to the customer’s request
- The size of the loan request relevant to the size of the bank
- The financial strength of the borrower
- The consistency of the loan structure and the bank’s objectives
- The quality and ability of internal control systems to provide early identification of weakening or problem loan situations
- The change of an existing facility.

The relationship between banks and borrowers can be viewed in terms of agency theory (Viganb, 1996), in the sense that there is a contractual relationship between principals and agents. To protect depositors and shareholders, the bank management must monitor the activities of borrowers as agent. This requires well-defined procedures, processes and models to skin loan portfolio.
A long the way to protect banks and other interested parties a problem loan strategies and early detection system have been developed to the tradition at credit decision process. Early detection of problem loans is considered as an important mean of protecting loan quality. The failure of the borrower to supply the bank with required timely information could be taken as an early warning signal of a potential problem loan situation. Evaluation of the causes of problem loans stands as a starting step of the early warning signals (EWS). Under the system of the EWS, the bank officer should be the primary source about potential problem borrowers. This contains certain degree of subjectivity, which could jeopardize the objectives of credit analysis game.
Fig. (4-1) *Classification of the early warning signals*

![Classification of the early warning signals diagram]

Options: OPERATIONAL, FINANCIAL, BANKING, MANAGERIAL
4-3-B: Credit Risk Analysis:

Among others, increasing global competition, structural increase in bankruptcies, disinter-mediation, reduced margins, declining and volatile values of collaterals and decline in business ethics and values have contributed to the concern of credit risk assessment.

Over the past few years, a surge in interest regarding credit scoring models has been driven primarily by two requirements of lending institutions: emphasis on increased efficiencies in the processing of applications and in making loans, and a desire to manage risky by creating consistent, fair methods for offering credit. The statistical models that are used for credit scoring have increased in complexity and flexibility over time to meet the evolving needs of those using them. Clearly credit scoring is a cost effective credit management tool.

The benefits of credit risk models are:

- The use of credit risk models offers banks a framework for examining the risk in a timely manner, this will contribute to an improvement in a bank’s overall ability to identify, measure and manage risk.
- Credit risk models may provide estimates for unexpected loss, which reflects portfolio composition.
• Models may be both influenced by and be responsive to, shifts in business lines, credit quality, market variables and economic environment.

• In addition, models may offer: a) the incentive to improve systems and data collection efforts; b) a more informed setting of limits and reserves; c) more accurate risk and performance-based pricing; and d) a more consistent basis for economic capital allocation.

From a supervisory perspective, the development of modeling methodology and the consequent improvements in risk management may bring capital requirements into closer alignment with the perceived riskiness of underlying assets and portfolio concentrations.

The history of banking shows that credit risk management in banks has evolved over years from qualitative judgmental to quantitative-judgmental. Shumway, (2001) stated: “Quantitative judgmental are more data based, analytical and structured compared to qualitative judgments”. The four popular approaches to credit risk analysis are:

1) Expert Systems
Expert system is experiential qualitative measure, here; managers can smell good and bad loans through their experiences.

2) Loan Rating or Grading System
It is the conventional classification of loans into healthy and unhealthy. Most banks in many countries classify their loans portfolio into five standards, namely, Other Assets Specially Mentioned (OASM) and substandard, doubtful and loss.

3) Loans as Options and KMV and other models
Many risk models have been developed recently. Option pricing formula of Black and Scholes (1973), Merton (1974), KMV, Credit At Risk (CAR), and Value-at-Risk (VAR).

4) Credit Scoring Systems
It is essentially a numerical grading system. Under this system, critical variables / attributes of an account are attached weights and scores. Basically ratings describe the creditworthiness of customers. In practice, the rating procedure is often more based on the judgment and experience of the rating analyst than on pure mathematical procedures with strictly defined outcomes. The analyst has to consider many rating drivers, such as; future earnings and cash flows, short and long-term financial obligations, capital structure (leverage), situation of the firm, market situation, and management quality. Statistical tools provide a first indication regarding the rating of a customer, but due to the various soft factors underlying a rating, the responsibility to assign a final rating remains the duty of the rating analyst.

4-3-1 Benefits of credit scoring:
The benefits that have led to the recent explosion in the usage of credit scoring include:

- Increased efficiencies and reduced costs: scoring systems remove much of the labor time traditionally associated with the origination of a loan. The models allow for immediate handling of the definite yes/no decisions.
• Reduced potential for bias: Banks will reduce the possibility of unfair lending practices.

• Ability to target specific risk segments: Banks can better price and reserve for the risk that they are explicitly taking on a portfolio basis.

• Learning systems: Credit scoring models are based on statistical comparisons to previous history. As such, the systems can learn over time.

• Simplified securitization: With standardized credit score, it is easier to rate a credit for the purposes of bundling and securitization.

4-3-2 The pitfalls:
While the benefits of credit scoring are fairly well known, the dangers of using these tools should not be ignored. The most essential cautions are below:

• The most basic risk is one that exists with any modeling process: Garbage in, garbage out (GIGO). Although these models are extremely complex, they are nonetheless only as good as the data feeding them. Inaccurate credit report information can invalidate results.

• Knowing your customer: The presence of a scoring system does not replace the value gained by knowing your customer. These models are not substitutes for knowing the borrower.
• Seasoning is important: Because these models are based on historical repayment data, they are susceptible to biases due to the time frame of the data and the business cycle.

• Dealing with a typical applicant: There is a potential to misdiagnose an applicant who does not fit the model.

• Privacy: Any time large amounts of data are drawn together into one place—particularly data that are as sensitive as income and employment information.

There are at least four methodological approaches to developing multivariate credit scoring systems:

(i) The linear probability model, (ii) the logit model, (iii) the probit model, and (iv) the discriminant analysis model. Altman et al. (1977) developed the now commonly used and referenced ZETA discriminant model. The most common form of discriminant analysis seeks to find a linear function of accounting and market variables that best distinguishes between two loan borrower classification groups—repayment and non-repayment. This requires an analysis of a set of variables to maximize the between group variance while minimizing the within group variance among these variables. Similarly, logit analysis uses a set of accounting variables to predict the probability of borrower default, assuming that the probability of default is logistically distributed i.e., the cumulative probability of default take a logistic functional form and is, by definition, constrained to fall between 0 and 1. Martin (1977) used both logit and discriminant analysis to predict bank failures. Both models gave the similar
classification results. Interestingly, the factors identified by these models are similar to the CAMEL rating components used by bank examiners. In general, the industry relative accounting ratio model outperformed the unadjusted model, (Platt and Platt, 1991a), and (Smith and Lawrance, 1995).

A class of credit scoring models with a strong theoretical underpinning is “risk of ruin” models. At its simple level, a firm goes bankrupt when the market value (liquidation) of its assets (A) falls below its debt obligations to outside creditors (B). Models of this type can be found in (Wilcox, 1973; Scott, 1981; and Hull and White, 1995), in many respects the risk of ruin model is similar to the option pricing model (OPM) of Black and Scholles, 1973), and (Merton, 1974). The POM depends on the volatility of the market value of a firm’s assets.

Another class of models is capital market based models, which are the mortality rate model of Altman (1988, 1989) and the aging approach of Asquith et al. (1989). These mortality default rate models seek to derive actuarial-type probabilities of default from past data on bond default by credit grade and years to maturity. It was adopted by many rating agencies (Moody’s, 1990, and Standard and Poor’s 1991).

A new approach is the application of neural network analysis to the credit risk classification problem. Essentially, neural network analysis is similar to non-linear discriminant analysis, in that it drops the assumption that variables entering into the bankruptcy prediction function are linearly and independently related. The neural network models explore potentially “hidden” correlations among the predictive
variables, which are then entered as additional explanatory variables in the non-linear prediction function. They were applied by: Altman (1994), Coats and Fant’s (1993), and Trippi and Turban (1996).

4-4-B: Expected Loss:

History shows that even good customers of banks have a potential to default on their financial obligations, such that an insurance for not only critical but all loans in the bank’s credit portfolio makes much sense. For bank loans one can suggest that; charging an appropriate risk premium for every loan and collecting these risk premiums in an internal bank account called expected loss reserve to create a capital cushion for covering losses arising from defaulted loans.

The bank can assigns to every customer a default probability (DP), a loss fraction called the loss given default (LGD), describing the fraction of the loan’s exposure expected to be lost in case of default, and the exposure at default (EAD) subject to be lost in the considered time period. The loss of any obligor is then defined by a loss variable. 

\[ L^* = EAD \times LGD \times L \quad \text{with} \quad L = Id, \]

\[ EL = EL^* = EAD \times LGD \times P(D), \text{where} \quad P(D): \text{Probability of default}. \]

The assignment of default probability can be done through two essentially approaches:

(1) Calibration of default probabilities from market data.
(2) Calibration of default probabilities from ratings.
4-5-B: How the models work?

The premise of credit scoring models is simple. A large sample of similar-type, historical loans are divided into those that paid and those that defaulted. Based on statistical probabilities, the combinations of borrowers' characteristics that differentiate the “good” from the “bad” loans generate a score that is an estimate of riskiness of each new loan of this type. Based on the score, the lender decides whether to make the loan and how to price it. In practice, applications are run through the model. Credit history information is combined with other data regarding an applicant’s ability to repay. The model then attempts to predict that applicant’s likelihood of default based on prior experience with applicants of a similar profile. Depending on the model, most will result in an accept/reject decision and suggest pricing commensurate with the riskiness of the credit, or indicate if the model is unable to determine risk due to a lack of information.

Many financial institutions and third party providers have developed models using various technologies and data sources. Nonetheless, the basic process does not vary substantially from model to model. The lender determines the criteria for judging the likelihood of repayment, and the acceptable risk levels for each criterion. In models provided by third parties, the criteria are predetermined, and the lender need only tailor the model to its desired risk levels. Some of
the common criteria used in these models are credit history, current income, investment / assets levels, home ownership, job stability, education level, debt-to-equity ratio, and current credit outstanding. It is important to note that there is no “magic bullet”. Effective scoring models are based on many characteristics, and the weightings of these and other factors vary from model to model.

Credit scoring is a natural and logical process in the domain of credit analysis development and innovation. It estimates the repayment probability based on the information in the credit application. Thus, credit scoring is highly built around prediction power. The estimation of prediction power is dependent on the ability of loan officer in reading in advance the probability of repayment or default. The risk literature denotes that the risk of default (R) as a relationship between the risk-free rate and the default (d). This could be stated in the following equations:

R will compensate the borrower probability of default for the bank. In case of no chance of default (d=0), the return (r) will equal the probability of default (R), when borrower is certain to default (d=1), R will be infinite or undefined. This situation R is undefined in the sense that the lender cannot be compensated for risk. No bank, of course, would make such a loan. Here, we can generate the default risk premium (DRP), which is the difference between the default risk (R) and the return (r).

The risk of default  
\[ R = (1+r/1-d) - 1 \]  
(1).

This is the equation of the risk of default that shows the relationship between the risk free rate and the default. If there is certainty of default, i.e. d = 1, then, R is undefined:
\( R = (1 + r/1 - 1) - 1 = & \) \hspace{1cm} (2)

If there is no default, \( d = 0 \), then the risk of default will be the return:

\( R = (1 + r/1) - 1 = r \), so \( R = r \) \hspace{1cm} (3)

The default risk premium (DRP) is the difference between \( R \) and \( r \), then rearranged as follows:

\( R - r \) is reflected as: \( (((1 + r)/(1 - d)) - r) \) \hspace{1cm} (4)

\( \text{DRP} = (r + d)/(1 - d) - r = d (1 + r) / (1 - d) \) \hspace{1cm} (5)

The return is related to the default as extracted here:

\( \text{DRP} = (d + rd) / (1 - d) \) \hspace{1cm} (6)
4-6-B: Credit risk management:

While financial institutions have faced difficulties over the years for a multitude of reasons, the major causes of serious banking problems continues to be directly related to lax credit standards for borrowers and counter parties, poor portfolio risk management, or a lack of attention to changes in economic or other circumstances that can lead to a deterioration in the credit standing of a bank’s counter parties.

Recent financial disasters in financial and non-financial firms and in governmental agencies point up the need for various forms of risk management. The goal of credit risk management is to maximize a bank’s risk-adjusted rate of return by maintaining credit risk exposure within acceptable parameters. Banks need to manage the credit risk inherent in the entire portfolio as well as the risk in individual credits or transactions. Banks should also consider the relationship between credit risk and other risks. The effective management of credit risk is a critical component of a comprehensive approach to risk management and essentially to the long-term success of any banking organization.

Bank regulators have a singular risk measurement goal. They want to know, to a high degree of precision, the maximum loss a bank is likely to experience over a given horizon. They then can set the bank’s required capital (i.e. its economic net worth) to be greater than the estimated maximum loss and be almost sure that the bank will not
fail over that horizon. Bank managers have a more complex set of risk information needs. In addition to shared concerns over sustainable losses, they must consider risk/return trade-offs.

Banks need to meet forthcoming regulatory requirements for risk measurement and capital. Pyle states that: “However, it is a serious error to think that meeting regulatory requirements is the sole or even the most important reason for establishing a sound, scientific risk management system.” Managers need reliable risk measures to direct capital to activities with the best risk/reward ratios. They need estimates of the size of potential losses to stay within limits imposed by readily available liquidity, by creditors, customers, and regulators. They need mechanisms to monitor positions and create incentives for prudent risk taking by divisions and individuals. Risk management is the process by which managers satisfy these needs by identifying key risks, obtaining consistent, understandable, operational risk measures, choosing which risks to reduce and which to increase and by what means, and establishing procedures to monitor the resulting risk position.

For most banks, loans are the largest and most obvious source of credit risk; however, other sources of credit risk exist throughout the activities of a bank, including in the banking book and in the trading book, and both on and off balance sheet. Banks are increasingly facing credit risk in various financial instruments other than loans, including acceptances, inter-bank transactions, trade facing, foreign exchange transactions, financial futures, swaps, bonds, equities, options, and in the extension of commitments and guarantees, and the settlement of transactions.
Since exposure to credit risk continues to be the leading source of problems in banks worldwide, banks and their supervisors should be able to draw useful lessons from past experiences. Banks should now have a keen awareness of the need to identify, measure, monitor and control credit risk as well as to determine that they hold adequate capital against these risks and that they are adequately compensated for risks incurred.

The banking industry is in a profound change in its credit risk management practices. Parallel developments in finance theory are reshaping the intellectual foundation of credit risk management and are transforming its day-to-day practices much as they transformed investment management in the last two decades. Also, rapid increases in the sophistication and calculation horsepower of information technology allow for potential levels of automation within credit risk management unimaginable even ten years ago. To succeed in the emerging environment, banks must embrace these changes willingly. Ignoring or resisting them will only open the door further open to aggressive bank and nonblank competitors.

For banks’ management to manage risk properly, it has to exert more efforts in the management of assets and liabilities of their banks. This process will be accomplished through the determination of the sensitive relationships of the balance sheet items as well as that of the income statement.

The first principle of asset management is to control the risk of insolvency by insuring that the market value of their asset portfolios remains equal to the value of their liabilities. For payment intermediaries there is an additional principle of asset management: In
In order to control the liquidity risk, they must hold a sufficient amount of cash to meet their clearing and currency drains, to accomplish this, part of the assets must be hold in the form of primary reserves in addition to secondary reserves. The commercial loan theory failed to provide the proper amount of the medium of exchange. Commercial loans did not provide the banks with adequate liquidity to meet the demand for cash, especially during crises. They depend on project’s income, which lead to liquidity risk and hence default or credit risk.

Liability management is not separated from the management of the bank’s assets. The public’s willingness to hold the deposit liabilities of banks depends on its confidence in their ability to convert its deposit account into cash, otherwise deposits will be withdrawn (runs) which may result into contagion, and this may result in funding risk. In the traditional financial system, the interest rate risk will take place. To facilitate the management of the interest rate risk two measures can be used:

1) *Maturity Gap Management (GAP)*: Here, assets and liabilities are grouped according to their sensitivity to interest rate. Rate sensitive assets less rate sensitive liabilities will tell the gap. I.e.

\[
GAP = RSA - RSL
\]

2) *Duration Gap Management (DG)*: It is the present value, time-weighted measure of maturity that considers the amount and timing of all cash flows. It is a measure of how long it takes for a security to pay bank its purchase price in present value terms.

\[
\text{Duration Gap} = Da - Db \left( \frac{L}{A} \right), \quad \text{where,} \quad Da: \text{Duration of assets, Db: Duration of liabilities, L: liabilities, and A: assets.}
\]
4-7-B: Principles for the management of credit risk:

A consultative paper issued by the Basel Committee on Banking Supervision (1999), provide about 17 principles to have an appropriate credit risk management:

**Principle 1:** The board of directors should have responsibility for approving and periodically reviewing the credit risk strategy and significant credit risk policies of the bank. The strategy should reflect the bank’s tolerance for risk and the level of profitability the bank expects to achieve for incurring various credit risks.

**Principle 2:** Senior management should have responsibility for implementing the credit risk strategy approved by the board of directors and for developing policies and procedures for identifying, measuring, monitoring and controlling credit risk. Such policies and procedures should address credit risk in all of the bank’s activities and at both the individual credit and portfolio levels. Policies and procedures that are properly developed and implemented enable the bank to: (i) maintain sound credit granting standards; (ii) monitor and control credit risk; (iii) properly evaluate new business opportunities; and (iv) identify and administer problem credits.

**Principle 3:** Banks should identify and manage credit risk inherent in all products and activities. Banks should ensure that the risks of products and activities new to them are subject to adequate procedures and controls before being introduced or undertaken, and approved in advance by the board of directors or its appropriate committee.
**Principle 4:** Banks must operate under sound, well-defined credit granting criteria. These criteria should include a thorough understanding of the borrower or counter party, as well as the purpose and structure of the credit, and its source of repayment.

**Principle 5:** Banks should establish overall credit limits at the level of individual borrowers and counter parties, and groups of connected counter parties that aggregate in comparable and meaningful manner different types of exposures, both in the banking and trading book and on and off the balance sheet.

**Principle 6:** Banks should have a clearly established process in place for approving new credits as well as the extension of existing credits.

**Principle 7:** All extensions of credit must be made on an arm’s-length basis. In particular, credits to related companies and individuals must be monitored with particular care and other appropriate steps taken to control or mitigate the risks of connected lending.

**Principle 8:** Banks should have in place a system for the ongoing administration for their various credit risk-bearing portfolios.

**Principle 9:** Banks must have in place a system for monitoring the condition of individual credits, including determining the adequacy of provisions and reserves. Effective credit monitoring system will include measures to: (i) ensure that the bank understands the current financial condition of the borrower or counter party; (ii) ensure that all credits are in compliance with existing covenants; (iii) follow the use customers make of approved credit lines; (iv) ensure that projected cash flows on major credits meet debt servicing requirements; (v) ensure that, where applicable, collateral provides adequate coverage
relative to the obligor’s current condition; and (vi) identify and classify potential problem credits on a timely basis.

**Principle 10:** Banks should develop and utilize internal risk rating systems in managing credit risk. The rating system should be consistent with the nature, size and complexity of a bank’s activities.

**Principle 11:** Banks must have information systems and analytical techniques that enable management to measure the credit risk inherent in all on and off balance sheet activities. The management information system should provide adequate information on the composition of the credit portfolio, including identification of any concentrations of risk.

**Principle 12:** Banks must have in place a system for monitoring the overall composition and quality of credit portfolio.

**Principle 13:** Banks should take into consideration potential future changes in economic conditions when assessing individual credits and their credit portfolios, and should assess their credit risk exposures under stressful conditions. Stress testing should involve identifying possible events or future changes in economic conditions that could have unfavorable effects on a bank’s credit exposures and assessing the bank’s ability to withstand such changes.

**Principle 14:** Banks should establish a system of independent, ongoing credit review and the results of such reviews should be communicated directly to board of directors and senior management.

**Principle 15:** Banks must ensure that the credit granting function is being properly managed and that credit exposures are within levels consistent with prudential standards and internal limits. Banks should establish and enforce internal controls and other practices to ensure
that extensions to policies, procedures and limits are reported in a timely manner to the appropriate level of management.

*Principle 16:* Banks must have a system in place for managing problem credits and various other workout situations.

*Principle 17:* Supervisors should require that banks have an effective system in place to identify, measure, monitor and control credit risk as part of an overall approach to risk management. Supervisors should conduct an independent evaluation of a bank’s strategies, policies, practices and procedures related to the granting of credit and the ongoing management of the portfolio. Supervisors should consider setting prudential limits to restrict bank exposures to single borrowers or groups of connected counterparties.

John Drzik (1998) outlined seven stages for bank credit risk management:

Stage 1: To make only good loans, here all key decision making processes are approved to distinguish between good and bad loans.

Stage 2: Loans should be graded. The relative riskiness of different loans is formally reorganized through the introduction of a loan grading scale.

Stage 3: To drive the return on equity (ROE), as it maximizes the shareholders value.

Stage 4: To price for risk, to measure and reflect default risk.

Stage 5: Manage the loan book. In this stage bank management seeks to apply modern portfolio theory to the management of a loan book.

Stage 6: Determine risk/return efficiency, to know better risk discrimination, correlation measurement, and to estimate unexpected losses.
Stage 7: Following diversification techniques, diversification is a paramount to achieving risk/return efficiency.

**4-8-B: Measuring Management Qualities:**

In evaluating the safety and soundness of commercial banks, examiners followed the CAMELs ranking system in U.S. commercial banks. Based on the score of each of these factors, an overall rating is assigned to each bank. The third factor in the acronym CAMEL (M) refers to the bank’s management quality. While the other factors can be quantified fairly easily from current financial statements, management quality is somewhat elusive and subjective measure, yet that is crucial to institutional success.

Since management quality is inextricably tied to a bank’s success or failure, it is important to develop and improve methods for grading management efficiency. Recent research by Barr, Killgo, Seims, and Zimmel (2002) generates a proxy for management quality that measures the relative productive efficiency of U.S. commercial banks from 1994 to 1998. The efficiency scores suggest that significant differences in performance and soundness exist between the most efficient and the least efficient institutions and point to the hump in the CAMELs rating as an important indicator of a bank’s ability to survive.

The important factors that determine the bank’s management efficiency were:

1) Return on Average Assets and Efficiency: It was positively related to the author’s efficiency measure.
2) Bad Loans and Efficiency: The percentage of non-performing gross loans reflects a strong difference between efficient and inefficient banks across varying industry conditions.

3) Risk and the Loan-to-Asset Ratio: It was found that, less risk adverse institutions are less efficient ones compared to their counterparts.
CHAPTER FIVE
RESEARCH METHODOLOGY
CHAPTER FIVE
RESEARCH METHODOLOGY

5-1 INTRODUCTION:
This chapter deals with the methodology used to predict financial distress, and how the data is collected and analyzed.
In this study, we defined the financially distressed bank as: (one whose liquidity or solvency is or will be impaired unless there is a major improvement in its financial resources, risk profile, strategic business direction, risk management capabilities and/or quality of management). The data were collected on the base of the above definition. Basel and the Bank of International Settlements classify banks into healthy and distressed banks on the base of our definition, which is conducted in this study. Data had been collected from six commercial banks out of the current population of 15 commercial banks (joint and governmental) that represent both healthy and distressed banks. The banks selected in the sample are:
1) Sudanese French Bank
2) Sudanese Islamic Bank
3) Altadamon Islamic Bank
4) Bank of Khartoum
5) Safa Investment and Credit Bank
6) Niema Bank
Two of the distressed banks were failed and liquidated (Safa and Niema), the other distressed bank (Bank of Khartoum) is still operating despite its classification as a distressed bank. The other first three banks of our sample are considered as healthy banks as they are not facing any of the conditions of financial distress during the period of the study.
The period covered by the study is between 1992 and 2000. Due to the difficulty of generating the data for the same financial periods, at least five financial periods (1992 – 1997) are common and will be analyzed for every bank in the sample. Although the period is short but it is suitable for both healthy and distressed banks, as some of the distressed banks cannot be covered after that period. The period after 1997 witnessed major changes in the banking sector (capital adequacy requirements), so our study extended up to year 2000.
We described in the literature many studies and presented some models of the prediction of failure. In this study we raise some questions to pose these previous studies (models or studies discussed in the literature section):
• Each previous study mentioned the list of all variables but did not clearly mention the detailed computation steps to obtain the variables. Income statements show a
summary of revenues for a specific period of time, such as a year. On the other hand, balance sheets show a list of the assets, liabilities and capital as of a specific date, usually at the close date of the last day of the fiscal year. Hence, the statements cannot be compared or computed directly. To compute the financial ratios using balance sheet accounts, it is necessary to use averages during the period to obtain accurate ratios. There are no previous studies mentioning this point.

- In previous studies generally, the method used to select variables is not clear. It is difficult to obtain the best set of variables at one try using statistical methods. However, previous studies never mentioned how to reduce or select the final set of variables from the initial variables set.

- In previous studies, bankrupt firms are matched against non-bankrupt. This pairing has not proven to be advantageous. Sample selection biases might also occur. Here, we did not concentrate on exactly failed and non-failed, but rather on a bank’s sample of two different criteria that range between healthy and distressed.

- In the past, the attention was paid to the change in the situation of the economy; this will affect all firms equally in the same country. In this study, we selected only financial conditions of the banks relevant to the standards and rules applied by the Basel, Bank of International Settlements, and the Bank of Sudan.
5-2 Multiple Discriminant Analysis (MDA):
The general problem of classification arises when an analyst has certain characteristics of observation and wishes to classify that observation into one of several predetermined categories on the basis of the characteristics. It is used primarily to classify and/or make predictions in problems where the dependent variable appears in qualitative form, for example, male or female, distress or healthy. Therefore, the first step is to establish explicit group classifications. The number of original groups can be two or more. Some analysts refer to discriminant analysis as “multiple” only when the number of groups exceeds two. We prefer that the multiple concepts refer to the multivariate nature of the analysis. The MDA determines a set of discriminant coefficients. When these coefficients are applied to the actual ratios, a basis for classification into one of mutually exclusive grouping exists.

Basically, discriminant analysis consists of three steps:

1) Establishing mutually exclusive group classifications:
   Each group is distinguished by a probability distribution of the characteristics.
2) Collecting data for each of the groups.
3) Determining linear combinations of the characteristics that best discriminate between the groups. By best, we mean those discriminations that minimize the probability of misclassification.

The MDA technique has the advantage of considering an entire profile of characteristics common to the relevant firms, as well as the interaction of these properties. A univariate study, on the other hand, can only consider the measurements used for group assignments one at a time. Another advantage of the MDA is the reduction of the analyst’s space dimensionally, that is, the number of independent variables equals the number of original a priori groups.

The studies of financial distress suggest that both market and accounting variables may provide incremental information when estimating distress probabilities. Most of the studies followed the multiple discriminant analysis (MDA) to analyze their results and generate the overall measure of the sample results (Francis 1990; Stone 1991; Han, Jennings, and Noel 1992; Dichec 1998; and Griffins and Lemmon 2002).

Other studies (Dhaliwal, Lee, and Farghar, 1992; Dhaliwal and Reynolds 1994; Opler and Titman 1994; Barth, Beaver, and Landsman 1998; and Billings 1999) have used related measures, such as leverage or bond ratings as proxies for bankruptcy risk. Additionally, Pinches and Mingo (1973) and Hartzell, Peck, and Altman (1995) have shown that several explanatory variables in the Altman and Ohlson models are important independent variables in bond rating prediction models, which are designed to capture credit
risk. Thus, researchers frequently rely on accounting-based proxies for the probability of distress.

The choice of explanatory variables is determined by the questions we posed in the study, the availability of data, and the previous results found in the literature. Our objective is to build up a simple model with few explanatory variables to predict the financial distress in Sudanese commercial banks. The main factors to consider are those of internal nature, i.e. factors determined through the financial ratios (internal factors). The study is not ignoring the macroeconomic and regulatory factors, but it assumes that; all banks are subject to the same macroeconomic variables (inflation, GDP, exchange rates…. etc) and also the same regulatory environment (Bank of Sudan rules, Stock market behavior, finance and investment policies). The study concentrates on different variables stated in many relevant models, such as: CAMEL, CART, Z-score and ZETA, The Chesser, and the CAEL model, neural networks and the Bayesian model. The study selects these models and uses the bank’s relevant ratios.

The study gathers financial statements (Balance sheet, Profit and loss account, Statement of Retained Earnings, and Cash Flow Statement) for five fiscal years. The financial data is collected for different dimensions of the previous mentioned models. Major difficulties are faced when looking for variables proxing for the risk dimension of the bank’s activity, such as the ratio of non-performing loans to total loans or the risk-adjusted level of capitalization. More than forty financial ratios will be tested for banks’ soundness. Thirteen variables are refined and used as potential predictors of distress with respect of the whole sample.
In Sudan, now there are about 26 banks of which; three are foreign banks, eight are joint ownership banks, four are specialized banks, and seven are government owned banks. The total number of commercial banks is eighteen (3 foreign, 8 joint, and 7 government), even though other banks are now commercial in nature. From the 15 joint and governmental commercial banks, the study selects six of them as a sample, in this sample, the base for choice was: all are commercial banks, every bank spent above six years in the service (to provide comparable data), all are registered in the stock market, and all these banks publish annual financial statements. The banks included in the sample are divided into two categories: three considered as healthy banks, the other three as distressed banks.

A key element in this study is the construction of the banking distress dummy variable. To do it, the study covers the period between 1992 and 2000 because the period is characterized by:

- Most banking crises are concentrated in this period, two cases of bank failure happened during this period.
- The availability of data during this period.
- Many transitions in the banking sector took place in this period as a result of financial distress, and also the Bank of Sudan adjustments to avoid failure cases.
- In this period the whole reporting system in Sudanese commercial banks was unified on the Islamic reporting standards. Both Islamic banks and traditional follow the same system to prepare their financial statements.
5-3 Ratio Analyses:
The use of financial ratios to make qualitative statements about the going concern or bankruptcy of the firm has a long history. However, the generality of constructed ratios are controversial. Financial ratios must thus be evaluated in conjunction with additional information related to the nature of the firm, trading cycle, degree of capital turnover, market competition, volatility of revenues, and the business operations. As emphasized by Morris (1989): A unique economic event can result in a variety of ratio patterns, and a single pattern of ratios can be the result of a variety of underlying economic conditions. Ratio analysis is the method used to interpret the financial statements. Prior to the development of quantitative measures of performance, agencies were established to supply a qualitative type of information in assessing the credit-worthiness of particular merchants (Dun & Bradstreet). Financial ratios are useful tool to enable a meaningful picture of the company’s affairs to be drawn from available financial information. It provides a considerable help both in interpreting a firm’s past and current performance and in predicting its future performance. The ratio analysis is used to evaluate the financial
condition of the firm by relating two pieces of financial data to each other. It involves two types of comparisons:

- First: the analyst can compare present ratio with past and expected future ratios for the same entity, and
- Second: Comparing the ratios of one firm with those of similar firms or with industry averages at the same point of time. However, it is important to mention that no one ratio gives sufficient information by which to judge the financial condition and performance of the firm. Only when we analyze a group of ratios we are able to make reasonable judgments.

After the initial groups are defined and banks selected, financial statements data are collected. Because of the large number of variables found to be significant indicators of banking problems in the literature and past studies, the study selects more than forty ratios and after data screening, thirteen financial ratios (variables) are subject to test. The variables are classified into five standard ratio categories; including liquidity, profitability, capital adequacy (activity), solvency (risk), and management quality, which interact with other ratios. The ratios are chosen on the basis of their popularity in the literature and their potential relevancy to the study.

In order to arrive at a final profile of variables, the following procedures are utilized:

- Observation of the statistical significance of various alternative functions, including determination of the relative contributions of each independent variable;
- Evaluation of intercorrelations among the relevant variables;
- Observation of the predictive accuracy of the various profiles;
- Application of different statistical tests,
- Analysis of the relationships with previous models, and
- Judgment of the analyst.

5-4 Data Mining Approach:
Several previous studies had used empirical approaches of initially choosing variables followed by stepwise procedure to select the variables in the final discriminant function. However, these studies are limited in their ability to provide generalizable results as to what financial variables can consistently predict financial distress.

Data mining approach was used to select the best set of the variables. The most popular and powerful mining tool is Classification and Regression Tree model (CART), which is now part of SAS program. The CART developed by Brieman, Friedman, Olshen and Stone (1984). The purpose of this classification in this study is to get an understanding of what variables or interactions of variables cause distress. The tree model develops a set
of data that are all possible ratios used to evaluate the performance of the banking sector (41 ratios) in different previous studies, then ratios with available data will remain (strong branches and stems with enough water) and incomplete data will be removed from the study (the far leaves will fall down).

CART model selects the variables accurately with no restrictions; therefore, all collected data can be used. In this study, when CART model is used to select the variables, the variables are also selected by Stepwise procedure to compare the results. Stepwise procedure requires the statistical assumption that the variables are normally distributed. To satisfy this hypothesis, data were grouped into four basic groups each will act as an indicator for certain measure of the bank. (Leverage, Liquidity, Profitability, and Activity measures). The variables were found to be similar by CART and Stepwise. It is generated that; 13 ratios (variables) (see table 6-1) are important and effective in the process of prediction. Other ratios are removed because: data were not enough for them, similar to some selected data, or are not relevant to the available financial reports.

In the literature, many financial ratios have been used as tools for the evaluation of the banking performance. The listed below are about forty-one relevant ratios.

1) *Cash and Treasury Securities / Total Assets*
2) Total Debts / Total Assets
3) Net Income / Total Assets
4) Operating Expenses / Total Assets
5) Equities*1 / Total Debts
6) Working Capital / Revenues
7) Revenues / Total assets
8) Cash Flow / Total Liabilities
9) Net profit / Equities
10) Total Expenses / Total Revenues
11) Loan Income / Total Assets
12) Taxation / Total assets
13) Retained Earnings / Total Assets
14) Earnings Before Zakat & Tax (EBZT) / Total Assets
15) Current Assets / Current Liabilities*2
16) Bad Loans / Total Loans
17) Working Capital / Total Assets
18) Net Income / Total Operating Income*3
19) Reserves / Total Operating Income
20) Loan revenue / Total Assets
21) Commercial Paper / Working Assets
22) Loan Income Due / Total Loans
23) Current Deposits (Liabilities)/Total Liabilities (Deposits)
24) Bank Deposits / Equities (Own Funds)
25) Fixed Assets / Total Assets
26) Risk Related Assets / Total Assets
As expected it has been found that some of the financial ratios have a high degree of correlation. If some variables are highly correlated, they have the same influence on the financial position of the bank. Financial distress is caused by many different factors. Therefore, it is important to assess a bank from different angles. Finally, we selected thirteen ratios to be analyzed as expected factors of financial distress in Sudanese commercial banks. The considerations that governed the process of ratio selection are:
(1) Data availability that permitted the calculation of ratios across banks and across years;

(2) Reasonableness and general acceptability of the ratios in relation to their intended use – the development of a discriminant function;

(3) The development of a comprehensive set of ratios by type: profitability, activity, liquidity, and indebtedness ratios. These types of ratios have been shown to have considerable merit in financial analysis and in the measurement of financial well being of banks.

*1: Equities: Own Funds of the bank. = Capital + Reserves + Last Year’s Undistributed Dividends.

*2: Current Assets: Cash and Reserves with other banks, while current liabilities are demand deposits and other banks’ liabilities due within the year.

*3: Total Operating Income = (Loan Income + Income from other sources of operations)

(4) Taking into consideration some environmental factors when selecting data such as; the latest regulations, accounting systems and procedures, and Islamic standards that affect the Sudanese banking system. The basic concentration is on the financial ratios of these banks.
After the initial groups are defined into healthy and distressed banks, banks selected, and financial statements data are collected. The thirteen variables have been selected to test through the Multiple Discriminant Analysis (MDA), to determine exactly the factors influencing financial distress of the commercial banks in Sudan.

The most obvious indicators that can be used to predict banking distress are those that relate directly to the soundness of the banking system. Items from banks’ balance sheets and/or income statements may make clear when risks are increasing and, thus, when problems are emerging. These variables may even be available at the level of individual banks, where system wide distress often originates, the deterioration of individual institutions may not be apparent in aggregate data.

Table (5-1) below lists the ratios used by the study:

*Table (5-1) Ratios Used in the Analysis:*

<table>
<thead>
<tr>
<th>Ratio</th>
<th>Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>(1) Indebtedness Measures</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td><strong>1- Debt Ratio</strong></td>
<td>Total Debts / Total Assets</td>
</tr>
<tr>
<td><strong>2- Equity Ratio</strong></td>
<td>Equities / Total Debt</td>
</tr>
<tr>
<td><strong>3- Deposits Structure Ratio</strong></td>
<td>Demand Deposits / Total Deposits</td>
</tr>
<tr>
<td><strong>4- Cash Flow to Debt</strong></td>
<td>Cash Flow / Total Liabilities</td>
</tr>
</tbody>
</table>

**Liquidity Measures:**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>5- Current Ratio</strong></td>
<td>Current Assets / Current Liabilities</td>
</tr>
<tr>
<td><strong>6- Capital-Assets Ratio</strong></td>
<td>Working Capital / Total Assets</td>
</tr>
</tbody>
</table>

**Profitability Measures:**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>7- Return on Assets</strong></td>
<td>Net Profit / Total Assets</td>
</tr>
<tr>
<td><strong>8- Retained Earnings to Assets</strong></td>
<td>Retained Earnings / Total Assets</td>
</tr>
<tr>
<td><strong>9- Operating Profits to Assets</strong></td>
<td>Earnings before Zakat &amp; Tax / Total Assets</td>
</tr>
<tr>
<td><strong>10- Shareholders’ Profits</strong></td>
<td>Net Profit / Equities</td>
</tr>
</tbody>
</table>

**Turnover measures:**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>11- Revenues Turnover</strong></td>
<td>Expenses / Revenues</td>
</tr>
<tr>
<td><strong>12- Capital Turnover</strong></td>
<td>Working Capital / Revenues</td>
</tr>
<tr>
<td><strong>13- Assets Usage</strong></td>
<td>Revenues / Total assets</td>
</tr>
</tbody>
</table>

*These ratios are explained in details in appendix (1)*

Many of these refined ratios were found to be effective for some of the previous studies, for example: Altman & Saunders (1997), found 5 of these ratios, Aziz & Lawson
(1989) achieved seven in cash flow reporting, and Andrelucas (2001) was able to use ten of the mentioned ratios. Most of the selected ratios are more common in the financial institutions rather than in the manufacturing sector.

5-5 Limitations of Ratio Analysis:
While ratio analysis is an effective tool for analyzing a bank’s financial profile, it is important to recognize some of its limitations:

(1) The data on which the ratios are based is usually historical in nature, which does not reflect either price level changes or the current market values. In this study we used the current value of equity to cope with the stock exchange information and overcome part of this limitation.

(2) There is no consideration for changes in estimates and some accounting principles that affect these ratios. We used ratios on the base of Islamic Standards for all banks to avoid different estimates and changes before the application of the Islamic Standards. Recently, a separate control department for Islamic dealings had been established to follow up such standards.

(3) Ratios specifically that of the balance sheet are provided only at the year-end, which may not represent exactly the annual events during the financial period. To minimize this limitation, we use average data for a range of ten years but this was not available for some banks basically for those who go bankrupt.

(4) Very close interaction can be noted for many of the ratios, which may affect the ability of the individual ratio in the process of forecasting. Here, we use the CART model to refine similar data and to select effective ratios that have the strongest predictability.
(5) The availability of information for some important ratios is limited, as they are not published in the financial statements, specifically for liquidated banks. For example, the ratio of non-performing loan does not exist in many of the banks, and it is difficult to extract it in different periods.
CHAPTER SIX
MODELLING OF
FINANCIAL DISTRESS IN
SUDANESE COMMERCIAL BANKS
CHAPTER SIX
MODELING OFFINANCIAL DISTRESS IN
SUDANESE COMMERCIAL BANKS

6-1 Introduction:

This chapter includes the analysis of the data collected and used in the study, its treatment, and preparation of the final development, testing and construction of the new model.

The objective of the study is to predict the determinants specifically, the financial variables that affect the financial distress in Sudanese commercial banks. As all banks are subject to the same economic situation, we concentrated only on internal and regulatory factors. These factors are closely related to the previously stated premises, so our analysis will be around the five premises already mentioned:

1) Financial ratios are the best predictors of financial distress in Sudanese commercial banks; the practical method to analyze their results is the multiple discriminant analysis.
2) Credit risk embodied in the banks’ lending process is considered as a real source of financial distress in Sudanese commercial banks.

3) The financial distress is a result of the interacted financial factors that affect the financial profile of the commercial bank.

4) The variables of the Z-model are considered in our model to predict financial distress in Sudanese commercial banks.

5) Banking regulations play an important role in stability of banking system in Sudan.

Data have been collected to satisfy analysis required for these hypotheses. The basic source of data is from the commercial banks and the Bank of Sudan through published financial reports and interviews with some of the authorities in these banks.

6-2 Identification of Financial Distress in Sudanese Banks:
The objective of this study is to build up a simple model with few explanatory variables to predict the financial distress in Sudanese commercial banks. The main factors considered are those of internal nature, i.e. factors determined through the financial ratios (internal factors). This selection is not an ignorance of the macroeconomic and regulatory factors, but because all banks are subject to the same macroeconomic variables (inflation, GDP,
exchange rates…. etc) and also the same regulatory environment (Bank of Sudan rules, Stock market behavior, finance and investment policies).

In order to test our previous hypotheses, first we need to determine the suitability of financial ratios in predicting the financial distress and distinguishing between healthy and distressed commercial banks in Sudan. Following the definition of distress we assume a tentative classification of two groups of the sample selected in this study of Sudanese Commercial Banks. The distressed banks are matched with three banks considered as healthy over five common financial periods.

The financial ratios are expected to give a reasonable measure for all of the hypotheses stated. For the efficiency of management it is difficult to define clearly the concept of management efficiency but it is somewhat easy to identify through performance measures.

The ratios stated and screened above, cover many of the variables of different models that forecast failure and distress. The data was selected to suit the different models mentioned in the hypotheses and the methodology.
6-3 The CAMEL model:

The components of the CAMEL model for rating and evaluating the performance of banks are available in the stated ratios. Also the components of this model are practiced and followed by operational guidelines of the Bank of Sudan.

1) Capital: A decline in capital ratio may be due to many reasons such as: increase in risk-weighted assets, reduction in capital, operating losses, and deteriorations in exchange rates.

Capital is measured by the capital adequacy ratio (risk-weighted, or equity to total liability) and the statutory minimum paid-up capital. A capital ratio is constructed from two components. The numerator is a measure of the capital of the firm and is inversely related to the probability of failure. The denominator is a measure of
the scale of the bank, and the taking of the ratio is necessary because one can only gauge whether capital is adequate in relation to some indicator of scale.

2) **Assets quality**: Asset quality problems can become serious in different ways. Provisions and written offs can result in the bank incurring losses, leading to a reduction in its capital adequacy ratio. But even if the bank continues to make a profit, poor asset quality can still pose problems, for three main reasons:

- If proper problem loan management does not deal with the problem, the loan written offs are likely to remain large.
- Problem loans in excess of the industry norms may indicate poor management.
- Poor asset quality, may affect the confidence in the bank, leading to deposit withdrawal or increased cost of funding.

The asset quality can be measured by TD / TA, RE / TA, EBZT / TA, or Rev. / TA.

3) **Management**: One of the main problems of distressed banks is their poor management. It can be viewed as the ability of the bank management to generate profit from the available resources under their direct controls and their efficiency and effectiveness of the different components of the financial statements. It can be measured through the capital regulation, operating profits / TA, revenues turnover, and liquidity management.
4) **Earnings:** Declining bank earnings may have different causes. These include:

- Unprofitable investments in new activities or in branches, subsidiaries or overseas operations.
- Insufficient diversification and unsustainable income streams.
- Unreliability of non-core income items.
- Poor cost control.
- Increased competition in core activities, leading to profit reduction.

Deteriorating earnings will lead directly to reduced liquidity and weaker solvency, so these problems must be addressed. Earnings can be valued through: Net Profit / TA, NP / E, and Rev. / TA.

5- **Liquidity:** Liquidity can be a problem when a bank’s holdings of cash and marketable assets provide little margin for comfort above the level necessary for business. It is possible that liquidity may be a problem in and of itself in the scenario where the bank expands its loan more quickly than it can secure adequate, reliable funding. Problem banks become insolvent far before they become illiquid. To measure the liquidity we can use the traditional ratio CA / CL, and the cash flow –debt ratio.
6-4 The Relevance of Z – Score:
One might ask at this stage, what is the relevance of Z-Score now that so many new concepts and techniques of analysis have already emerged on the scene? The answer to this question lies in the fact that the newer models and approaches as discussed previously require for their implementation current values or market prices data which are possibly available only in efficient financial markets, that types of markets we are looking to have. In our emerging markets, price data are either not available or highly unrepresentative or unreliable. Altman, (2001)
states: “In these kinds of markets, techniques like the Z-Score are still very relevant”.

Z – Score belongs to the linear credit scoring system as a classificatory model. The best revised fitting scoring Altman’s model for commercial loans took the form:

\[ Z = 0.717X1 + 0.847X2 + 3.107X3 + 0.420X5 + 0.998X6 \]

The critical value of the model is 1.81, a score above 2.99 would be classified as good, and this model was applied in manufacturing companies.

To use the Z-Model, we have to apply it for banks without the fifth ratio (X5, Sales / Total Assets). The Z-Score proved to be the best model, although it has some limitations:

1) It ignores non-linearity and correlations among Xs.
2) It may suffer from garbage-in-garbage-out (GIGO), as it uses constant accounting figures.

6-5 How to Build a Z-Score?:
We followed the following steps to build our own Z-Model in Sudanese Commercial Banks:

**Step1**: Select Financial Ratios: Here, we select all relevant ratios that include the relevant variables of Altman’s Z-Model. The ratios represent different classes of analysis to have some comprehensive results. See (table 6-3)

**Step2**: Select the Sample: Six commercial banks out of a population of 15 commercial banks were selected, based
on the definition of financial distress introduced by this study, banks are classified into healthy and distressed and not failed and non-failed.

**Step 3**: Compute Financial Ratios: The study computed the selected financial ratios for a range over 5 years at least for the two groups of banks.

**Step 4**: Group Distinctiveness: This will show the difference between the two groups of the sample. The means and standard deviations are very useful for such distinction.

**Step 5**: Check for Out-Liers: Outliers means extreme observations. Such observations which vitiate averages should be identified and excluded from the analysis. Scatter plot Matrix can be used for identifying out-Liers, through SPSS.

**Step 6**: Perform Discriminant Analysis: At the end of step 5, we will be ready to compute the Z-function. Finally, determine cutoff points.

Following the above steps, we tested the variables of the Z-Model in the sample of our commercial banks. It is evident from the analysis conducted under this study that Altman’s Z-Score Model is not successful as applied in developed countries. It is found that some components of the Z-Model ratios are irrelevant to our study; and cannot applied to generate the coefficients similar to that of the original model, This may be due to many reasons:
• The size of the sample differs between the studies.
• The Z- Model classified firms into bankrupt and non-bankrupt, while we classified banks into distressed and healthy.
• Some ratios are not relevant to our study, such as the Sales / Total assets which is applicable to private manufacturing companies.
• The great variation between the economic conditions and the efficiency of the stock market.
• The current Sudanese business and banking customs, practices and environment are drastically different from that of USA. As noted by Altman himself, Z score has to be country, industry, time and size specific.

Here, we can return to our third premises and conclude that our premises cannot be applied as the components; economic conditions and economic sectors are totally different.

6-6 The Modeling of Banking Financial Distress:
To build a model, we have to consider the constraints of the financial statements. Our analysis of the distress starts from the financial statements to determine the factors influencing financial distress. Here, the balance
The balance sheet shows exactly the structure of the bank, which is the most important factor to evaluate the health of the commercial bank. The balance sheet of the bank is constructed as follows:

\[ A + R = D + B + EQ \]  \hspace{1cm} (1)

Where:  
\begin{align*}
A &= \text{assets}, \\
R &= \text{Reserves (legal and other reserves)}, \\
D &= \text{Deposits (all types of deposits)}, \\
B &= \text{Notes issued by the bank, and} \\
EQ &= \text{the bank’s equity.}
\end{align*}

The capital is the main factor on the basis which other items have to be measured. It is the first condition to be satisfied when any bank is to be established. The equity as a function of the balance sheet components can be expressed as follows:
\[ EQ = A + R - D - B \]  \hspace{1cm} (2)

The insolvency is a critical issue in the performance of commercial banks. Distress occurs when the banking firm faces a decrease in revenues generated from the bank’s assets to the extent that it becomes less than the bank’s expenses or costs. Here the equity of the bank will start to decrease and at a time this loss may be higher than the bank’s equity, as expressed in equation (3) below:

\[ AE - C < - EQ \]  \hspace{1cm} (3)

Where: \( AE \): revenues earned on assets, or assets’ earnings, and

\( C \): the operational cost incurred by a specific bank.

When this cost becomes greater than revenues, equity will start to decrease.

When the revenues from assets provide a value less then relevant operating costs, the above equation can be re-written as:

\[ AE < - EQ + C \]  \hspace{1cm} (4)

From equation (2) and (3), the balance sheet constraint can be expressed as follows:

\[ AE - C < - (A + R - D - B) \]  \hspace{1cm} (5)

It is possible then to drive the expression of the revenue \( AE^* \) under which the bank faces distress:

\[ AE < D + B + C - A - R = AE^* \]  \hspace{1cm} (6)

It is worth noticing the link between solvency and liquidity; other things being equal, the higher the level of
reserves R, the higher is the critical value of $\Delta^*$. Under this situation, the profitability will decrease, and the risk of distress will also decrease. These equations can provide an absolute measure for the bank’s profile. Any mismanagement of the previous balance sheet items represented by the last equation will indicate the distress situation of the individual bank. In this study, to have an accurate prediction, we use financial ratios with statistical relationships instead of the given absolute evaluation.

All commercial banks seek to maximize their profitability in order to overcome the different types of costs relevant to the assets possessed by the bank and its healthy condition. The maximization of profitability requires enough and adequate capital, tight management of assets and liabilities, and more considerations for cost minimization and by the way profit maximization. These interrelated factors will help banks to control risk and avoid the rise of financial distress.

Hence, the above equations can provide a means for the analysis of banking distress and performance, such as; increases in deposits and notes issued will reduce the cost of capital and support profit maximization, while, increases in the costs of illiquidity and distress will reduce the bank’s profitability.

The expected loss on loans provided will increase costs and decrease the profitability of the bank. This is why
credit risk is an important determinant factor for banking distress.

6-7 The multiple discriminant analysis:

In this study, we have by now thirteen financial ratios for six banks and we wish to use these ratios to classify the banks into healthy and distressed banks. Discriminant analysis is a statistical technique that allows such classification. Basically, discriminant analysis consists of three steps:

1. Establishing mutually exclusive group classifications,
2. Collecting data for each of the groups, and
3. Deriving linear combinations of the characteristics that best*(1) discriminates between the groups.

The means and standard deviations of the selected thirteen variable profiles for healthy and distressed banks are shown in table (6-2) and the comparison of the two groups in the chart of appendix (2). Moreover, in comparing the means and standard deviations between the two groups it is clear that the two groups (healthy and distressed) are clearly distinguished from each other. Specifically, all the figures taken together indicate that the financial ratios are capable, in principle, of highlighting financial distress and the health of the two groups of banks. The means of twelve of the thirteen variables are very high in the healthy banks compared to the same ratios of the distressed banks.
*(1) By best we mean those discriminations that minimize the probability of misclassification.

However, only one ratio is found to be higher in the distressed group, which are expenses to revenues ratio, this result will strengthen the discrimination power between the two groups of our study. Higher expenses to revenues are indicators of failure (see table 6-2 and the chart of the different ratios in appendix 2). The student T-Test and the F-statistics are used to check the significant differences between the two groups of the sample. Means and standard deviations slightly discriminate between healthy and distressed banks. To know correlation and covariance among and between these two groups, many statistical tools within the multiple discriminate analyses under the SPSS program are applied to give clear results.
<table>
<thead>
<tr>
<th>Group</th>
<th>Ratio</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Healthy</td>
<td>TD / TA</td>
<td>92.8000</td>
<td>3.3637</td>
</tr>
<tr>
<td>Distressed</td>
<td></td>
<td>92.4667</td>
<td>3.2921</td>
</tr>
<tr>
<td>Healthy</td>
<td>EQ / TD</td>
<td>18.2667</td>
<td>6.4749</td>
</tr>
<tr>
<td>Distressed</td>
<td></td>
<td>11.1333</td>
<td>5.0831</td>
</tr>
<tr>
<td>Healthy</td>
<td>CL / TL</td>
<td>74.6667</td>
<td>9.5668</td>
</tr>
<tr>
<td>Distressed</td>
<td></td>
<td>57.5333</td>
<td>16.5178</td>
</tr>
<tr>
<td>Healthy</td>
<td>CF / TD</td>
<td>14.6667</td>
<td>7.2473</td>
</tr>
<tr>
<td>Distressed</td>
<td></td>
<td>8.6000</td>
<td>3.2249</td>
</tr>
<tr>
<td>Healthy</td>
<td>CA / CL</td>
<td>134.0000</td>
<td>47.0562</td>
</tr>
<tr>
<td>Distressed</td>
<td></td>
<td>74.0667</td>
<td>27.9169</td>
</tr>
<tr>
<td>Healthy</td>
<td>WC / TA</td>
<td>22.7333</td>
<td>11.9730</td>
</tr>
<tr>
<td>Distressed</td>
<td></td>
<td>8.6000</td>
<td>2.5014</td>
</tr>
<tr>
<td>Healthy</td>
<td>NP / TA</td>
<td>9.1333</td>
<td>4.5177</td>
</tr>
<tr>
<td>Distressed</td>
<td></td>
<td>8.1333</td>
<td>3.2042</td>
</tr>
<tr>
<td>Healthy</td>
<td>RE / TA</td>
<td>9.0667</td>
<td>5.3648</td>
</tr>
<tr>
<td>Distressed</td>
<td></td>
<td>5.4000</td>
<td>1.1212</td>
</tr>
<tr>
<td>Healthy</td>
<td>EBZT / TA</td>
<td>8.0667</td>
<td>3.4115</td>
</tr>
<tr>
<td>Distressed</td>
<td></td>
<td>7.4667</td>
<td>3.7007</td>
</tr>
<tr>
<td>Healthy</td>
<td>Distressed</td>
<td>NP / EQ.</td>
<td>EXP. / REV.</td>
</tr>
<tr>
<td>----------</td>
<td>------------</td>
<td>------------</td>
<td>------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>11.8000</td>
<td>67.0667</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7.1534</td>
<td>22.8644</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.7767</td>
<td>16.3803</td>
</tr>
</tbody>
</table>

In order to arrive at a final profile of variables determining financial distress, the following procedures are utilized:

(1) Observation of statistical significance of various alternative functions including determination of the relative contributions of each independent variable;

(2) Evaluation of inter-correlations between the relevant variables;

(3) Observation of the predictive accuracy of the various profiles; and

(4) Judgment of the analyst.

From the original list of variables (13 ratios), four variables are selected as doing best overall job together in the prediction of financial distress. The variable profile finally established did not contain the most significant variables, amongst the thirteen original ones, measured independently. The contribution of the entire profile is
evaluated, and since this process is essentially iterative, there is no claim regarding the result of the discriminant function. The function, however, does the best job among the alternatives, which include numerous computer runs analyzing different ratio profiles. The final discriminant function is as follows:

\[ Z = -5.203 + 0.081X_1 - 0.147X_2 + 0.125X_3 + 0.059X_4 \]

Where:

- \( Z \) = Overall Index,
- \( X_1 \) = Revenues / Total Assets,
- \( X_2 \) = Net Profit / Equities,
- \( X_3 \) = Working Capital / Total Assets,
- \( X_4 \) = Current Liabilities / Total Liabilities.

1) \( X_1 \)- *Revenues to Total assets*: This ratio shows the ability of the assets to generate total revenues disrespect to any matched expense. It is used to evaluate the activity of the assets and the efficiency of the management in using of these assets. Here, the credit side of the income statement is compared to the debit side of the balance sheet to declare internal sources of funds relevant to the basic uses of funds. In the literature and previous studies, this ratio proved to be a significant measure of banks’ performance because most of the expenses in the banks are non-avoidable so the performance cannot be measured on such included expenses. This ratio is consistent with the study of Beaver (1976), Pantalone and Platt (1987), and Allen (1995).
2) \( X_2 \) – *Net Profit to Equity:* This is a profitability measure used to show how much is the profit generated by the capital invested by the owners of the bank. For any bank to attract new investors and increase the value of its shares in the stock market and also to keep healthy operations, it has to generate more profits relevant to the capital invested. Net profit is considered after Zakat and tax, while equity is the total of capital in terms of shares, reserves, and unpaid dividends. The target here is the shareholders rather than other sources of finance. The equity is recently determined through tough rules suggested by the Basel and the Bank for International Settlements, and even applied by the Bank of Sudan. The minimum capital required is $12 million or S.D. 3 Billion, any bank is asked to achieve this target with a determined period or to be merged with another one or either will distressed or even failed one. This variable was found to be common in many studies of failure such as; Demirguc and Maksimovic (1998), Estrella (1999) and Acharya (1988). Generally, failure started by decreases in profits.

3) \( X_3 \) – *Working Capital to Total Assets:* This ratio is frequently found in studies of banking problems, as a measure of the net liquid assets of the bank relative to the total capitalization. Working capital is the difference between current assets and current liabilities. Liquidity and size characteristics are explicitly considered,
ordinarily, a bank experiencing consistent operating losses will have shrinking current assets in relation to total assets. Inclusion of this ratio is consistent with the Altman study (1968 and 1993) and Aziz and Larson (1989).

4) **X4- Current Liabilities to Total Liabilities:** It is a ratio of deposit structure: This ratio is simply comparing demand deposits to the total deposits of the bank. It is an important leverage ratio that will show the ability of the bank to depend on future deposits to minimize the risk inherited in the short-term deposits. Demand deposits are subject for retention at any period of time, which will make banks responsible for very accurate management of its current assets and reserves and also to a high degree of liquidity risk. The inclusion of this variable is consistent with only one study highlighted in the literature that is, of Sobodu (1996) in Nigeria. Thus the structure of deposits may be of a specific nature in Sudan and Nigeria.

To conclude the above variables represent the different groups of financial ratios stated and tested in this study. The variable of revenues to total assets is from the group of turnover ratios, net profit to equity represent the profitability ratio, working capital to total assets is the heart of the liquidity ratio, and the current liabilities to the total liabilities represents the structure of deposits which is an indebtedness group of ratios. The next table summarizes the ratios, their coefficients and classes:
<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients</th>
<th>Class of Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenues / Total Assets</td>
<td>0.081</td>
<td>Turnover Ratio</td>
</tr>
<tr>
<td>Net profit / Equity</td>
<td>-0.147</td>
<td>Profitability Ratio</td>
</tr>
<tr>
<td>Working Capital / T. assets</td>
<td>0.125</td>
<td>Liquidity Ratio</td>
</tr>
<tr>
<td>Current Liab. / T. Liab.</td>
<td>0.059</td>
<td>Indebtedness Ratio</td>
</tr>
</tbody>
</table>

Now, we can explain the meaning of the coefficients generated in our model. There is a negative constant of –5.203; this constant will always reduce the value of the Z-score by 5.203. The first determinant variable is the revenues to total assets; its coefficient is 0.081, which means that for any increase in the ratio by one unit, the Z-score will increase by 0.081. The second coefficient is the net profit to equity ratio, which indicates that an increase in the equity ratio by 100% will reduce the Z-score by 14.7%. The increase in working capital to total assets and current liabilities to total liabilities by 100% will reduce the Z-score by 12.5% and 5.9% respectively. Most of the discriminant coefficients of the final variables of the model display positive signs, except the net profit to equity, which indicates negative profits or losses. Therefore, the greater the bank’s distress potentiality, the lower is its discriminant score. The coefficients of 0.081, 0.125, 0.059, and –0.147 for the variables of revenues to total assets, working capital to total assets, current liabilities to total liabilities, and net
profit to equity respectively indicate the strong ability of theses variables in the discrimination between distressed and healthy banks.

One useful technique in arriving at the final variable profile is to determine the relative contribution of each variable to the total discriminating power of the function, and the interaction between them.

To test the individual discriminating ability of the variables, an “F”* test is performed. This test relates the difference between the average values of the ratios in each group to the variability (or spread) of values of the ratios within each group. (See appendix (2) for more details). Variables X1 through X4 are all significant at different levels of significance, indicating extremely significant differences between the two groups of banks.

The “F” test can be used to show the degree of variance and covariance matrices between the two groups with Box’s M* test. Box’s M test is used to test the null hypothesis that: H0: Variance / covariance matrices of the two groups are the same in the population.

*F-value is the ratio of the sum-of-squares between-groups to the within-groups sum-of-squares.

In the study, Box’s M was found to be 454.418 and the approximate F is 2.414, differ under the degrees of freedom, we can accept the null hypothesis.
We can observe that the Z function of Sudanese commercial banks is quite far away from Altman’s Z function. The above coefficients of the variables and other relevant statistics are good evidences for that.

6-8 *The Discriminant Power of the Model:*

The analysis provided helps us to determine the discriminant power of the model. It might be helpful to
illustrate the format for presenting the result. In the classification result, actual group membership is equivalent to the a priori groupings and the model attempts to classify correctly these banks. Since, the discriminant coefficients and the group distributions are derived from the sample; a high degree of successful classification is expected. The classification matrix is as follows:

**Table (6 - 3) Classification Results**

<table>
<thead>
<tr>
<th>Group</th>
<th>Predicted group membership</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2*</td>
</tr>
<tr>
<td>Original</td>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Cross Validated</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>%</td>
<td>1</td>
<td>86.7%</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>13.3%</td>
</tr>
</tbody>
</table>

*1 stands for healthy banks and 2 for distressed banks.

100% of original group cases correctly classified.

86.7% of cross-validated grouped cases correctly classified.

The model is definitely accurate in classifying 86.7% correctly. The type I error proved to be 13.3%, while the
type II error was zero. This accuracy is highly acceptable when compared to Martin model 76%, Hanweek model (1998) 79%, and Seiford and Seims (2001) with 84%. Eigenvalue # is of great use in determining the discriminant power of the model. If it provides a value of zero, this means that, the model has not any discriminatory power. Otherwise, the model is able to discriminate between the two groups. In this study the Eigenvalue is equal to 3.071, which show the high ability of the model to discriminate between the group of healthy and that of distressed banks.

Another way to determine the degree is through the positive Wilks’ Lambda *, which is greater than zero in our study i.e. 0.246. It is another indication of the discriminant power of the model.

# Eigenvalue: indicated by \( \lambda = \frac{BSS}{WSS} \), the relationship between: Between group Sum of Squares and within group Sums of Squares.

* Wilks’ Lambda: is the ratio of within group Sums of Squares to Total group Sums of Squares. \( \Lambda = \frac{WSS}{TSS} \).
6-8-1 The Cut-off Points:
The cut-off point is the degree of separation between the
groups of distressed and healthy banks. The limits are the
centroids generated in the model which are 1.693 for the
group of healthy banks and – 1.693 for distressed banks,
as provided in appendix 2, (the functions at group
centroids). When the bank’s ratios are weighted by the
estimated coefficients in the Z function, they have to
provide the relevant Z-score. The Z-score has certain
limits that separate between healthy and distressed banks.
The Z-cutting is the mean of the two means of the groups
in case the two groups are equal in size. The Z-cutting of
the model was found to be 26.647. The limit of the
healthy banks is 31.5 whereas 21.791 for the distressed
banks. The explanation for these results is that: If the Z-
score is greater than the critical value of 21.791 the bank
is healthy, if the Z function is above 31.5 the bank is
classified as a distressed one; and the gray area.(area of
distress and healthy banks) is when the score is below
For a bank to stay healthy it has to make a profit but
profitability loses its value if the bank is not liquid. The
profitability is the result of assets turnover and the ability
to generate revenues from the available assets. Finally, a
bank is required to pay more attention to its deposits
structure, as it is the main source of bank’s risk and
hence affecting directly its profitability.
The unstandardized Z function carries an additional term, called constant, whose value in the case of our Z function is – 5.203. Standardized Z function does not have this term. Unstandardized Z function is preferred when we work with variables expressed in standardized unit of measurement, like the financial ratios in our study.

At the end of this chapter, we can conclude that:

- The variables used in the analysis were thirteen ratios divided into four main groups. Data were collected from six banks under five financial periods to predict the financial distress of Sudanese commercial banks.
- The multiple discriminant analysis was used to discriminate between the two groups of healthy and distressed banks. Different tools under this methodology were applied to provide comprehensive analysis for the study.
- The final model is composed of four variables and a constant. The variables represent the different groups of ratios with the relevant coefficients. The validity of the model and its ability to predict financial distress was tested, and the model give a high degree of discriminatory power.
- We can state that the Sudanese commercial banks are subject to different types of distress and at different
levels. The financial statements can provide comprehensive analysis for the banks.

- The efficiency of managers, regulators and the regulatory factors can be measured through the use of many financial ratios reflected in this study, so the regulatory factors are one of the main variables of financial distress.
7-1 Summary:
The objective of this study is to determine the factors and determinants of financial distress in Sudanese Commercial Banks in order to develop an early warning
system that can be used as a tool for identifying distressed banks.

The study is the first to be conducted in Sudan and it the only concerned with financial distress in Sudanese commercial banks. The concept of distress is one of the wide concepts of failure, which may finally lead to failure and liquidation. Many definitions can be followed to distinguish between distressed and healthy banks. The study follows the one applied by the Basel Committee for weak banks but it customizes it for distressed banks from a financial point of view. The Basle Committee defines the weak bank as: a combination of or one of: (1) Inadequate capital or liquidity, (2) poor asset quality, (3) poor management, and (4) weak systems and controls. To replicate the definition for our study, we followed some practical definitions followed by the Bank of Sudan, these can be one or more of these:

Distress is identified in one of the following definitions:

1) The closure of the bank,
2) The merger of the bank with another,
3) The recapitalization of the bank by the Central Bank; and
4) The inability of the bank to collect its loans for a considerable period.

The analysis covers five years for two groups of commercial banks that may be classified as healthy and distressed following the above definition. About 41 ratios
has been selected to test the bank performance. Due to the data mining applied and the logical selection of ratios only 13 ratios were found to be practical and effective for the performance evaluation of commercial banks. The methodology followed to test the predictive ability of these ratios was the multiple discriminant analysis (MDA).

In Sudan, due to the type of ownership commercial banks can be divided into: governmental, joint, and private or pure commercial banks. Relevant to the ideology, these banks may be classified as: Islamic and traditional banks. Irrespective to the classification, the financial reports are similar in all commercial banks, the reports are prepared subject to the Islamic Accounting Standards, and all banks are following the same rules and regulations issued by the Bank of Sudan under the same credit and fiscal policy. The financial statements are characterized to be of high quality relevant to the other types of businesses. We can conclude that all financial ratios will be applied across the whole commercial banks, and all banks in the industry are subject to the same models selected and tested. The only difference between banks is in the size of their assets, capital, the way the bank is managed, and its lenient or tough credit policy. These factors are considered as financial variables that differentiate between healthy and distressed banks.
7-2- **Conclusions:**

On the base of the analysis carried out by this study one can derive the following conclusions:

1) This is the first study to be conducted for the prediction of financial distress in Sudan and specifically in Sudanese Commercial Banks. One can conclude that the prediction of financial distress is less successful in Sudan compared to that provided by other studies in developed economies. This can be evidenced by the lower accuracy rates and coefficient factors, when other models applied in Sudan. The reason may be due to the instability of the banking conditions in Sudan, other external factors, and the effect of external intervention from the government, the regulations issued by the central bank, and the negative effects made by some shareholders in certain banks.

2) Many models had been tested in this study to show its relevance to the literature. The Z- Score model is found to be less relevant because its components are more relevant to the manufacturing companies rather than to banks, and it depends on current information available in the stock markets. The CAMEL rating system is well suiting our case, as it concentrates on capital, assets quality, management, earning quality, and the liquidity problem. All these are problematic factors in our study. The neural network has three different layers that need more and short time data available in an efficient stock
market, these data may not be easily generated in Sudan. In this manner, we selected different ratios and developed our own model to predict financial distress in Sudanese Commercial banks.

3) The new model generates four effective financial ratios to predict the financial distress in Sudanese Commercial banks. The ratios reflect the different problems of the banking sector in Sudan, starting with the structure of banks’ deposits, profitability, liquidity, and the inadequate capital (balance sheet relationships). The working capital to total assets has its highest coefficient, then the revenues to total assets, the current deposits to total liabilities, the net profit to equity, and finally a constant. These variables were found to be common in many of the previous studies. In Chesser model (1976), Capital to total assets variable proved to be also in this model, and another variable was found in the Z-Score model, which is the total revenue to total assets. The CART model had been used for data mining approach to decrease the tested variables to only 13 ratios. Here, the new model is more relevant to the Z-model, although it cannot be replicated for the case of Sudan.

4) To predict financial distress, the multiple discriminant analysis (MDA) is chosen as the best methodology to be used in constructing our new model. It is the methodology that followed by the Z and Zeta models.
The premises stated in this study, are tested during the results of the new model. It is found that: the financial ratios are really the best predictors of financial distress and the best way to test them is the multiple discriminant analysis, so we can accept the first premises. In the second stated premises, the credit risk is considered as a basic determinant of distress but as the results of the model show, that this premises is rejected. The third one is referring distress to the interacted financial ratios, this is true when looking to the components of the new model. The Z-Score components are to some extent important to our study, so some of these components were available in this study. Finally, the regulatory factor can be considered as an important determinant of financial distress as can be shown from the management of the different resources of the bank. The discriminants variables in this study are:

\[ Z = -5.203 + 0.081X_1 - 0.147X_2 + 0.125X_3 + 0.059X_4 \]

Where:  
\( Z \) = Overall Index,  
\( X_1 \) = Revenues / Total Assets,  
\( X_2 \) = Net Profit / Equities,  
\( X_3 \) = Working Capital / Total Assets,  
\( X_4 \) = Current Liabilities / Total Liabilities.
7-3: **Policy Implications:**

From the literature of previous studies provided here, and the financial analysis carried out in this study, one can provide the following points as policy implications of the study or as recommendations:

- Due to some definitions of failure or distress followed in some developed economies, most of the Sudanese banks can be classified as failed banks. The size of the Sudanese Commercial banks is non-comparable to the standard size in other developed countries, so these banks are going to face many challenges during the age of globalization and the rapid advances in information systems and technologies. These banks are required to increase their assets, enhance capital, and properly manage their debts and resources in order to cope with the rapid competition and to meet the needs and advances in the economy of the Sudan.

- There is no magic formula that can accurately measure or predict the distress in commercial banks but the model constructed by this study can be used as a basis for that purpose. In this respect, it is better to pay more attention
to the variables that appear in this model. The structure of Sudanese Commercial banks is a critical issue here, this why the proper management and control of assets, liabilities, lending process, liquidity as well as the adequacy of capital are very important issues for banks, shareholders and policy-makers.

- It is better for every bank to depend on its own internal rating system for its borrowers, to manage the credit risk, the liquidity risk, assets gap as well as its needs for capital and external finance.

- Due to the recent cases of failure, the Bank of Sudan, has to enforce properly its credit policy, reserve policy, activate its guarantee fund, and to solve the problems of insolvent banks before the occurrence of failure. The Central bank has to apply tough rules to reach the minimum required capital determined by the Basel Committee. Here, the prediction of financial distress is an important guide to the commercial banks and the Central Bank to get use of early warning signals.

- The role of the stock market is not effective during the period of this study. The banks, the central bank, the government, and the stock market are required to work hard in order to construct a competitive stock market in which the information is easily generated, accurate, useful, relevant, and reliable for researchers and policy makers. If the stock market becomes efficient, many
advanced and accurate models can be applied to give early signals for any problem.

- An other recommendation is that this study can be a base for further researches, it can be extended and replicated in different directions such as;

(i) The model developed in this study can be tested for other groups of banks, for example; specialized banks, or all banks or can cover another period of time to see the consistency of its results.

(ii) The model can be tested in other less developed country to see its degree of consistency and ability to predict financial distress there.

(iii) A further study can be conducted to show the ability of factors other than financial in the prediction of failure or distress in the banking sector.

(iv) Methodologies other than multiple discriminant analysis (MDA) can be applied like; neural networks, logit analysis, hazard models, and probabilistic models to compare their results with this model.

The sample of banks can be selected in other ways, for example; relevant to the size of the bank, or its credit policy, or its capital, or its profitability, or the structure of its ownership to compare the results with the ones generated here.
Bibliography


28) Basel Committee on Banking Supervision; “Amendment to the Capital Accord to Incorporate


36) *Bell T., Ribar G., and Verchio J.*; “Neural Networks Vs. Logistic Regression in Predicting Bank Failures in: P. Srivastava ed.” *Auditing Symposium X (University of Kansas), (1990).*


61) Detragiache and Demirguc-Kunt; “The Determinants of Banking Crises in Developing and


76) **Gerald P. Dwyer, Jr. and R. W. Hafer**; “Bank Failures in Banking Panics: Risky Banks or Road Kill?” *gdwyer@dwyerecon.com* (2002).

735-3537.


78) **Gilbert, L. R., K. Menon and K. B. Shwartz**; “Predicting bankruptcy for Firms in Financial Distress”


104) Kryzanowski L., and Roberts g. S.; “Perspectives on Canadian bank Insolvency During the 1930s” *Journal of Money, Credit, and Banking*, (1999), Vol. 31 No.1.


134) **Shirata C. Y.**; “Financial ratios as Predictors of Bankruptcy in Japan: An Empirical Research” *Tsukuba College of Technology Japan*, [www.cindy@cs.k.tsukuba-tech.ac.jp](http://www.cindy@cs.k.tsukuba-tech.ac.jp), (2002).


Appendix (1)

Definition of the ratios used in the study

1) Debt Ratio: This ratio is measured by comparing total debt to the total assets of the bank. The ratio is a useful one, specifically, in the determination of the bank leverage. It compares two items of the balance sheet on average base, to know the ability of the bank to repay back its debts (short and long-term debts) from its total available assets. The ratio had been used in many of the previous studies and showed a strong indicator for business failure in many of them.
2) Equity Ratio: It is measured by comparing the market value of equities to the book value of the total liabilities. Equity is measured by the combined market value of all shares of stock plus the reserves and undistributed dividends, while liabilities include both current and long term (total deposits + other liabilities). The measure shows how much the bank’s assets can decline in value (measured by market value of equity plus debt) before the liabilities exceed the assets and the bank becomes insolvent. This ratio adds the market value dimension, which was considered, only by Altman (2000) but the market value considered here only after 1998 (Khartoum Stock Exchange data) because of the unavailability of data before that period.

3) Deposit Structure: This ratio is simply comparing demand deposits to the total deposits of the bank. It is an important leverage ratio that will show the ability of the bank to depend on future deposits to minimize the risk inherited in the short-term deposits. Demand deposits are subject for retention at any period of time, which will make banks responsible for very accurate management of its current assets and reserves and also to a high degree of liquidity risk.

4) Cash Flow-Debt ratio: The ratio is an indicator for the ability of the bank to pay its total liabilities from its cash inflows that change from one financial period to another as a result of different operating, investing, and financing
activities. It is a balance sheet and cash flow statement ratio. The income statement dimension is also included in this ratio because the income statement is the main source of operating activities. It was very difficult to measure the cash flow in the first years of the study (it was not one of the required reports), later; the cash flow statement is required as an essential report by the Islamic Accounting Standards.

5) Current Ratio: This is one of the traditional and important liquidity measures. It is used to show the ability of the bank to repay its short-term debts form its available current assets. The current assets are cash in the bank, cash with other banks and correspondents, current reserves and very short-term investments, while current liabilities are the demand deposits and other liabilities to be repaid within the financial period.

6) Capital-Assets Ratio (WC / TA): The basic measure of this ratio is through the comparison between working capital and total assets. The ratio frequently found in studies of corporate problems, as a measure of net liquid assets of the bank relevant to the total capitalization. Working capital is defined as the difference between current assets and current liabilities. Ordinarily, a bank experiencing consistent operating losses will have shrinking current assets in relation to total assets. This ratio proved to be the most valuable of liquidity ratios in the banking sector.
7) Return-On-Assets Ratio (ROA) = NI / TA: This ratio is a profitability measure. It is a measure of overall effectiveness in generating profits with available assets. It shows a comparison from two financial statements (Income Statement and Balance Sheet). The Nominator is the result for the whole financial year, while the denominator is an average measure for the assets held by the bank.

8) Earnings-Assets Ratio (RE / TA): a Retained earnings is the account that reports the total amount of reinvested earnings and/or losses of a bank over its entire life. The account is also referred to as earned surplus. It should be noted that the retained earnings account is subject to manipulation via corporate quasi-reorganizations and stock dividend declarations. This measure is of cumulative profitability over time, hence it is affected by the life of the bank, so banks lived for a long period with considerable retained earnings may provide an indication for healthy situation. The age of the bank is implicitly considered in this ratio. This ratio is a measure for leverage, profitability, and the efficiency of the management of the bank. Those banks with high-retained earnings relative to total assets have financed their assets through retention of profits and have not utilized as much debt. It also indicates the ability of the management to take such decisions.
9) Operating profits –To- Assets Ratio (EBZT / TA): The ratio of operating profits to total assets is measured by the relationship between earnings before Zakat and taxes and the total assets of the bank. The ratio is a measure of the true productivity of the bank’s assets, independent of any external payments. Furthermore, insolvency in the distress sense occurs when the total liabilities exceed a fair valuation of the bank’s assets with value determined by the earning power of the assets. The EBZT (earning before Zakat and tax measure) is the substitute for the earning before interest and tax in traditional banks. In Sudan all banks are following the Islamic accounting system in which interest is prohibited. So there is no difference between traditional and Islamic banks in this manner.

10) Shareholders’-Profit Ratio (NP / EQ): This is another profitability measure used to show how much is the profit generated by the capital invested by the owners of the bank. For any bank to attract new investors and increase the value of its shares in the stock market and also to keep healthy operations, it has to generate more profits relevant to the capital invested. Net profit is considered after Zakat and tax, while equity is the total of capital in terms of shares, reserves, and unpaid dividends. The target here is the shareholders rather than other sources of finance. The equity is recently determined through tough rules suggested by the Basel and the Bank
for International Settlements, and even applied by the Bank of Sudan. The minimum capital required is $12 million or S.D. 3 Billion, any bank is asked to achieve this target with a determined period or to be merged with another one or either will distressed or even failed one.

11) Revenues Turnover (Expenses / Revenues): It is an important activity measure extracted from the income statement that simply compares annual total expenses with annual total revenues. This is a basic matching principle followed by accounting standards. It is required to tell exactly how much expenses are paid to generate the target revenues, so any expense had to be matched against revenue. The expenses of operating and non-operating nature are to be considered. The Bank of Sudan issued a circular as part of its policies and asked commercial banks to minimize their administrative expenses to a minimum rate to at least 55% of their total revenues. This indicates that the bank expenses are huge and extending. If banks followed systematically this ratio, they will keep themselves healthy.

12) Capital-To-Revenues (WC / TR): This ratio is used to show how much are the net current assets relevant to the annual revenues collected by the by the bank. It tells how the activity of working capital in the generation of revenues to keep in balances between both liquidity and profitability contradiction. Here, capital is required to be
invested to generate profit and also turned easily into cash to face the problem of liquidity if there.

13) Assets Usage Ratio (Revenues / TA): This ratio is to show the ability of the assets in generating the total revenues disrespect to any matched expense. It is used to evaluate the activity of the assets and the efficiency of the management in the usage of these assets. Here, the credit side of the income statement is compared to the debit side of the balance sheet to declare internal sources of funds relevant to the basic uses of funds. In the literature and previous studies, this ratio proved to be a significant measure of banks’ performance because most of the expenses in the banks are non-avoidable so the performance cannot be measured on such included expenses.
Appendix (2)

The statistical Analysis