CLASSIFICATION OF NIGERIA BANKS BASED ON FINANCIAL STABILITY

USING LINEAR DISCRIMINANT ANALYSIS

***ADEBOYE N.O., **AJIBODE, I. A.**
Department of Mathematics & Statistics
Federal Polytechnic, Ilaro
Ogun State
e-mail: *adeboye_olawale@yahoo.com, **ilesanmiajibode@yahoo.com

ABSTRACT

This paper focused on classification of Nigeria commercial banks into stable and non-stable banks. The research work is aimed at deriving a model that can be used to identify distressed banks. A sample of ten (10) commercial banks were selected and a linear discriminant function was fitted based on the bank profit before tax, profit after tax, asset, share capital and earnings per share as predictors variables. The parameter were analyzed with the aid of SPSS, which produced a linear discriminant function D=0.131 profit before tax,-0.445 profit after tax + 1.045 asset +0.569 earnings per share – 0.115 share capital for the classification of the banks into its various categories. The model is adjudged to be a good fit for the data with Wilks lambda value of 0.568 and a p-value of 0.001 which is less than 0.05. The classification is such that, once a bank's score on the discriminant function is closer to 0.694, then the bank is classified as been stable or reliable while a bank's score closer to -1.041 classified it as been unstable. All the ten (10) banks sampled were found to be stable after carrying out the classification rule. It is recommended that discriminant model can easily and accurately identify banks that may likely be distressed.

Keywords: Classification, Stable, Unstable, Depositors, Discriminant

1.0 INTRODUCTION

A bank or a credit institution is a transaction center. Capital is not always optimally distributed regarding time and place: some people have insufficient funds (people buying their first homes) and others have excess funds (a wealthy retired person with low expenses). A bank works as a distribution center, by pooling excess funds from those with sufficient funds and at the same time works as a clearing house (Mamman and Sunday, 1994). Interest is economically seen as a fee paid for the privilege to use borrowed money. A bank pays an interest to a depositor and charges interest from the borrowers. The banks` business idea is based on the concept of charging borrowers more than what they paid depositors. The difference is the profit a bank makes.

Confidence in the bank's solvency is what sustains this business model in the face of risk management. Depositors and other lenders roll over their hard earned resources to the bank when they are confident that the bank will continue to be solvent and viable. Due to their importance in the financial system and influence on national economies, banks are highly regulated in most countries. Banking was adopted by many countries, when they saw the importance to the economy (Kochi, 1994). Most nation have institutionalized a system known as fractional reserve banking, under which banks hold liquid assets equal to only a portion of their current liabilities (Nagalakshini, 2015). In addition to other regulations intended to ensure liquidity, banks are generally subject to minimum capital requirements based on an international set of capital standards, known as the Basel Accounts (Aja-Nwachukwu, 1993). Keeping money in its cutting edge sense developed in the fourteenth century in the rich urban communities of renaissance Italy yet from multiple points of view was continuation of thoughts and ideas of credit and loaning that had its foundations in the antiquated world.

Most commercial banks never have even a fraction of the funds they have promised to give to depositors if they request for it at a point in time. If too many depositors withdraw a large or considerable amount of money simultaneously a bank will not be able to complete all the withdrawal request. This is called a Bank-run usually leads to bankruptcy.

Confidence in the bank's solvency is what sustains this business model in the face of such instability. Depositors and other lenders roll over their loans to the bank, or other lenders replace them, when they are confidence that the bank will continue to be solvent and viable. On the other hand, fear about the future viability and solvency of the bank provokes expectations of delayed or non-repayment and precipitates withdrawal of loans by existing lenders and deters others from replacing them. Gearing, market-based funding models, potential off-balance sheet exposures and other complexities in their operating models may further exacerbate these fears.

Miguel and Charles (2009) in their study, reported that, the proper estimation of distress dependence amongst the banks in a system is of key importance for the surveillance of stability of the banking system. Financial supervisors recognize the importance of assessing not only the risk of distress i.e. large losses and possible default of a specific banks, but also the impact that such an event would have on other banks in the system. Clearly, the event of simultaneous large losses in various banks would affect a banking system's stability, and thus represents a major concern for supervisors. Bank's distress dependence is based on the fact that banks are usually linked in either direction. Through lending to common sectors and proprietary trades. Bank's distress dependence varies across the economic cycle, and tends to rise in times of distress since the fortunes of banks decline concurrently through either contagion after idiosyncratic shocks, affecting inter-bank deposit markets and participations in syndicated loans or through negative systemic shocks, affecting lending to common sectors and proprietary trades. Therefore, in such periods, the banking system's joint probability of distress; i.e. the probability that all the banks in the system experience large losses simultaneously, which embeds banks' distress dependence, may experience larger and nonlinear increased than those experienced by the probabilities of distress of individual banks.

Consequently, it becomes essential for the proper estimation of the banking system's stability to incorporate banks' distress dependence and its changes across the economic cycle. Quantitative estimation of distress dependence, however, is a difficult task. Information restrictions and difficulties in modeling distress dependence arise due to the fact that distress is an extreme event and can be viewed as a tail event that is defined in the "distress region" of the probability distribution that describes the implied asset price movements of a bank.

Distress in the banking industry generally occurs when banks are either illiquid and/or insolvent and depositors fear the loss of their deposits and so there is a breakdown of contractual obligations (Ebhodaghe, 1997). Ekpenyong (1994) affirmed that bank shows early sign(s) of distress when it is unable to meet its financial obligations that fall due (illiquidity) such as inter-bank indebtedness and depositors' funds. Such a situation as he further adds can be caused by the weak deposit base of the bank, its inability to meet its capitalization requirements and poor management.

Distress is also seen when a bank is adjudged deficient in a number of performance criteria. These include the following. Gross under capitalization in relation to the level of operation; illiquidity, reflected in the inability to meet customers' cash withdrawals. Low earnings, resulting from huge operational losses; and weak management, reflected in poor credit quality, inadequate internal controls, high rate of frauds and forgeries literature on banking distress distinguish between generalized and systemic distress, depending on the extent, and depth of the problem. Confidence is defined in terms of the ratio of total deposits of distressed banks to total deposits of the industry, the ratio of total assets of distressed banks to total assets of the industry, and the ratio of total branches of distressed banks to total branches of the industry (CBN, NDIC, 1995).

Many factors are responsible for Bank distress in Nigeria amongst are; The Financial Sector Distress Sub-committee (1994) emphasized by Minshkin (1997), observes that distress in the banking industry emanates from a number of exogenous and endogenous factors. The exogenous factors include adverse economic condition, inhibitive policy environment, political instability, interference in management, and impact of deregulation while Endogenous factors in the other hand include under capitalization, manpower problems, mismanagement, fraud etc. Another way of categorizing the causes of bank distress is from the micro and macro environmental factors (Gavin and Hausmann, 1996). Yet, others categorized them into internal and external factors (Obadan, 1997). Whichever, there is very little divergence of opinion that distress in the banking industry is a manifestation of complex set of inter-related problems which emanate from a number of factors (De Juan, 1991 and Ebhodaghe, 1996).

In this paper, we focus attention on the classification of Nigeria commercial banks into stable and non-stable banks and fit linear discriminant function/analysis on the bank profit before and after tax, asset share capital and earnings per share as predictor variables. The structure of the paper is as follows: section 2 describes materials used and an overview of discriminant analysis frame-work. We present discussion of results in section 3. Concluding and recommendation remarks in section 4.

2.0 MATERIALS AND METHODS

The factors that determines the financial position of a bank are profit before tax, profit after tax, share capital, earnings per share and asset were used. We consider the financial position of year 2010-2013. The analysis intends to bring into focus the state of the banks as at year 2012 in order to confirm or disprove the CBN examiners report on their state of affairs as at that date. This was the most current CBN examiners report available as at the time of carrying out this research.

A sample of 10 banks were selected out of 23 available banks in the country. They include Diamond bank, UBA, First bank, GT bank, Zenith bank, Wema bank, Skye bank, Eco bank, Access bank and Unity bank. The choice of these sample sizes was as a result of series of consolidation, merger and acquisition exercise that took place in the banking industry over the years, which have made most of the Nigerian banks vulnerable in terms of uniform preparation of annual reports. The statistical tool employed in the research work is Discriminant Analysis.

Discriminant analysis is not a classification algorithm although it makes use of class labels. However, discriminant analysis result is mostly used as a part of a linear classifier. Thus, given a list of potential predictors, one can determine which variables are most effective in predicting performances. It provides a discriminant function which includes only those variable that should be used in predicting performances. Probably the biggest advantage of discriminant function over regression is that it measures the predictive ability in terms of correct classification. This is possible since the unit of analysis is categorical (Agresti, 1996). It predicts category membership; given the true grouping of criterion. One can determine how many predictions produced by the equations are right. Fagoyinbo, Akinbo and Ajibode (2013) employed discriminant analysis in the classification of students performance based on exposure to academic risk in Nigeria Polytechnics. Moreover, discriminant function analysis is a multivariate analysis of variance, the independent variables are the groups and the dependent variables are the predictors. Suppose that our population consists of two groups, π_1 and π_2. We observe a $p \times 1$ vector $\underline{X}$ and must assign the individual whose measurements are given by $\underline{X}$ to π_1 or π_2. If the parameters of the distribution of $\underline{X}$ in π_1 and π_2 are known. We may use this knowledge in the construction of the assignment rule. If not, we use samples of size N_1 from π_1 and N_2 from π_2

Fisher (1936) suggested using a linear combination of observations and choosing the coefficients so that the ratio of the differences of the means of the linear combination in the two groups to its variance is maximized.

In Fisher's approach, let the linear combination be denoted by:

$$Y=\lambda'\underline{X} \quad (1)$$

Then the mean of Y is $\lambda'\underline{\mu}_1$ in π_1 and $\lambda'\underline{\mu}_2$ in π_2; its variance is $\lambda'\Sigma\lambda$ in either population if we assume that the covariance matrices $\Sigma_1 = \Sigma_2 = \Sigma$. Then we wish to choose λ to maximize:

$$Q = \frac{(\lambda'\underline{\mu}_1 - \lambda'\underline{\mu}_2)^2}{\lambda'\Sigma\lambda} \quad (2)$$

Differentiating Q with respect to λ, we have

$$\frac{\partial Q}{\partial \lambda} = \frac{2(\underline{\mu}_1 - \underline{\mu}_2)(\lambda'\underline{\mu}_1 - \lambda'\underline{\mu}_2)\lambda'\Sigma\lambda - 2\Sigma\lambda(\lambda'\underline{\mu}_1 - \lambda'\underline{\mu}_2)^2}{(\lambda'\Sigma\lambda)^2} \quad (3)$$

Equating $\frac{\partial Q}{\partial \lambda} = 0$, we have

$$\underline{\mu}_1 - \underline{\mu}_2 = \Sigma\lambda\left[\frac{\lambda'\underline{\mu}_1 - \lambda'\underline{\mu}_2}{\lambda'\Sigma\lambda}\right] \quad (4)$$

Since λ is used only to separate the two populations then λ may be multiplied by any constant. Thus, λ is proportional to $\Sigma^{-1}(\underline{\mu}_1 - \underline{\mu}_2)$ i.e. $\lambda \; \alpha \; (\underline{\mu}_1 - \underline{\mu}_2)$.

If the parameters $\underline{\mu}_1$, $\underline{\mu}_2$ and Σ are known, then the linear discriminant function is given by:

$$Y = \left(\underline{\mu}_1 - \underline{\mu}_2\right)' \Sigma^{-1} \underline{X} \qquad (5)$$

But if the parameters are unknown, the usual practice is to estimate them by Ξ_1 , Ξ_2 and S. Then the linear discriminant function is given by:

$$Y = (\Xi_1 - \Xi_2)' S^{-1} \underline{X} \qquad (6)$$

In general form, for P-measurement made on sample sizes N_1 and N_2 from population I and II respectively give the result below:

Table 1: Classification of Individual Samples

Π_1		Π_2	
SAMPLE	**MEASUREMENTS**	**SAMPLE**	**MEASUREMENTS**
	$X_1 \quad X_2 \quad \cdots \quad X_p$		$X_1 \quad X_2 \quad \cdots \quad X_p$
1	$x_{11} \quad x_{21} \quad \cdots \quad x_{p1}$	1	$x_{11} \quad x_{21} \quad \cdots \quad x_{p1}$
2	$x_{12} \quad x_{22} \quad \cdots \quad x_{p2}$	2	$x_{12} \quad x_{22} \quad \cdots \quad x_{p2}$
$\vdots$	$\vdots$	$\vdots$	$\vdots$
N_1	$x_{1N_1} \quad x_{2N_1} \quad \cdots \quad x_{pN_1}$	N_2	$x_{2N_2} \quad x_{2N_2} \quad \cdots \quad x_{pN_2}$
Total	$\sum_{i=1}^{N_1} x_{1i} \quad \sum_{i=1}^{N_1} x_{2i} \quad \cdots \quad \sum_{i=1}^{N_1} x_{pi}$	Total	$\sum_{i=1}^{N_2} x_{1i} \quad \sum_{i=1}^{N_2} x_{2i} \quad \cdots \quad \sum_{i=1}^{N_2} x_{pi}$
Mean	$\bar{x}_1 \quad \bar{x}_2 \quad \cdots \quad \bar{x}_p$	Mean	$\bar{x}_1 \quad \bar{x}_2 \quad \cdots \quad \bar{x}_p$

The mean vector of measurements in π_1 is given by: $\Xi_1 = (\overline{x_1}\ ,\overline{x_2}\ ,\ldots\ \overline{x_p})'_{1xp}$

The mean vector of measurements in π_2 is given by: $\Xi_2 = (\overline{x_1}\ ,\overline{x_2}\ ,\ldots\ \overline{x_p})'_{1xp}$

The covariance between measurements in π_1 is given by P x P matrix:

$$S_1^2 = \frac{1}{N_1 - 1}\sum_{i=1}^{N_1}(\underline{X}_{1i} - \Xi_1)(\underline{X}_{1i} - \Xi_1)' \tag{7}$$

The covariance between measurements in π_2 is given by p x p matrix:

$$S_2^2 = \frac{1}{N_2 - 1}\sum_{i=1}^{N_2}(\underline{X}_{2i} - \Xi_2)(\underline{X}_{2i} - \Xi_2)' \tag{8}$$

In general, the covariance between measurements in π_j is given by:

$$S_{ij} = \frac{1}{N_j - 1}\sum_{i=1}^{N_j}(\underline{X}_{ji} - \Xi_j)(\underline{X}_{ji} - \Xi_j)' \tag{9}$$

Where i = 1,2, ... , N_j ; j = 1, 2

Hence, the pooled variance is given by pxp matrix:

$$S_{pooled} = \frac{(N_1 - 1)S_1^2 + (N_2 - 1)S_2^2}{N_1 + N_2 - 2} \tag{10}$$

The inverse of S_{pooled} is given by S_{pooled}^{-1}

Therefore, the linear discriminant function:

$$Y = \lambda'\Sigma^{-1}\underline{X} = (\Xi_1 - \Xi_2)'S^{-1}\underline{X} \tag{11}$$

where $\underline{X} = (x_1, x_2, \ldots, x_p)'$.

From the above, the expected value of Y with respect to π_1 is given by $\overline{Y_1} = (\Xi_1 - \Xi_2)'S^{-1}\,\Xi_1$ and with respect to π_2 is given by $\overline{Y_2} = (\Xi_1 - \Xi_2)'S^{-1}\,\Xi_2$ where Ξ_j is the mean vector of measurements in jth population; j= 1,2. $\overline{Y_j}$ is the mean discriminant score for jth population; j = 1,2.

Then, the midpoint of means $\overline{Y_1}$ and $\overline{Y_2}$ is given by:

$$\frac{\overline{Y_1} + \overline{Y_2}}{2} = \frac{1}{2}[(\Xi_1 - \Xi_2)'S^{-1}(\Xi_1 + \Xi_2)'] \tag{12}$$

Which is otherwise called the cut off point for the assignment. Since the discriminant function:

Y = $\lambda'\underline{X} = \lambda_1 x_1 + \lambda_2 x_2 + \ \dots + \lambda_p x_p$

Where $\lambda_1, \lambda_2, \dots \dots, \lambda_p$ are arbitrary constants.

Then the discriminant score for ith individual is defined by:

$Y_i = \lambda_1 x_{1i} + \lambda_2 x_{2i} + \ \dots + \lambda_p x_{pi}$, i = 1, 2, ... N_j ; j = 1, 2

Where

x_{1i} = represents the score of i-th individual in measurement x_1;

.

.

x_{pi} = represents the score of i-th individual in measurement x_p , i = 1, 2, ... N_j ; j = 1, 2

Table 2: Discriminant Scores for Individual Population

Π_1	Π_2
$Y_1 = \lambda_1 x_{11} + \lambda_2 x_{21} + \cdots \lambda_p x_{p1}$	$Y_1 = \lambda_1 x_{11} + \lambda_2 x_{22} + \cdots \lambda_p x_{p1}$
$Y_2 = \lambda_1 x_{12} + \lambda_2 x_{22} + \cdots \lambda_p x_{p2}$	$Y_2 = \lambda_1 x_{21} + \lambda_2 x_{22} + \cdots \lambda_p x_{p2}$
$\vdots$	$\vdots$
$Y_{N_1} = \lambda_1 x_{1N_1} + \lambda_1 x_{2N_2} + \cdots \lambda_p x_{pN_p}$	$Y_{N_1} = \lambda_1 x_{1N_2} + \lambda_1 x_{2N_2} + \cdots \lambda_p x_{pN_2}$

Assignment Rule:

For i = 1,2, ..., N_j ; j = 1,2

Assign ith individual to π_1 if $Y_i > \frac{\bar{Y}_1 + \bar{Y}_2}{2}$ and to π_2 if $Y_i \leq \frac{\bar{Y}_1 + \bar{Y}_2}{2}$

3.0 RESULTS AND DISCUSSION

A discriminant analysis was conducted to predict the stability of commercial banks in Nigeria. The analysis was carried out on 10 commercial banks with respect to 5 predictor variables given as profit before tax, profit after tax, share capital earnings per share and shareholders fund.

The analysis of the data was carried out with the aid of SPSS 17, which portrays the information needed in predicting the state of the banking sector. The results are presented in the following table:

Table 3: Structure matrix

	Function
	1
Asset	.863
Profit before tax	.391
Earnings per share	.253
Profit After Tax	.251
Share capital	.125

Source: SPSS output of the analysis

Table 4: Discriminant function coefficients

	Function
	1
Asset	1.045
Profit before tax	0.131
Earnings per share	0.569

Profit After Tax	-0.445
Share capital	-0.115

Source: SPSS output of the analysis

Table 5: Summary of canonical discriminant functions

Eigen values

Function	Eigen value	% of variance	Cumulative %	Canonical correlation
1	.761[a]	100.0	100.0	.567

a. First 1 Canonical discriminant function were used in the analysis.

Table 6: Wilks' lambda

Test of function(s)	Wilks' lambda	Chi-square	Df	Sig.
1	.568	20.0091	5	.001

Source: SPSS output of the analysis

Table 7: Function at group Centroids

1 = stable 2 = unstable	Function 1
Reliable	.694
Unreliable	-1.041

Source: SPSS output of the analysis

From the analysis in table 3; assets and profit after tax are the most important predictors. This is because the variables have large co efficient, and so they stand out as those that strongly predict allocation to the reliable and unreliable groups. Profit before tax, share capital, earning per shares are less successful predictors.

This discriminant function fitted from table 4 is given as:

D = 0.131 profit before Tax – 0.445 profit after tax + 1.045asset +0.569earnings per share -0.115 share capital

The equation shows the partial contribution of each variable to the discriminate function controlling for all variables in the equation and can be used to predict current state of the commercial banks in the country. The variables should be unweighted before been entered into the equation i.e. reducing its figure power to decimals in order for it (variables) to act in accolade with the range of acceptance or rejection. The category it falls into is been determined by the cut scores in table 7. If the banks score on the discriminant function is closer to 0.694 we conclude that the bank is stable (reliable), otherwise we say it is unstable. If the banks score on the discriminant function is however closer to -1.041, we classify bank as been unstable. The cross validated classification for each of the banks shows that the discriminant scores of all the ten (10) banks are closed to being stable, given a 76.1% of an overall correct classification by the CBN reports.

4.0 CONCLUSION AND RECOMMENDATION

The commercial banks studied are currently stable and there is low probability of falling short of this status in the next few years i.e if the banks are subjected to proper management and there is no sudden global economic meltdown which generally affects every sector in the economy. Besides reductions in the value of dollar tend to affect the conclusion of this result, since all foreign reserve are kept in dollars. Investment in the banks will not lead to loss, in fact the purchasing powers of the shares will increase as the bank expands in operation and stability.

Based on the statistical analysis, it is recommended that

1. The CBN should set up a committee, to monitor the state of the banks on a yearly basis. This will prevent unnecessary diversion of money or funds by the bank management
2. The banks should be transparent about their monetary state, publishing out lies to share holders and board of committee will only lead to unrecoverable fall. A typical example of such case is oceanic bank, intercontinental bank and spring bank. They were later merged with other banks.
3. Uncalculated risk will definitely bounce back on the bank asset. Risk management committee should be set up, who will accurately evaluate the risk before it is been taken.
4. Share should be sold to the members of the public, as this will increase the operational capital and in turn increase the capacity of the banks.
5. Advertisement on social Medias will increase the public awareness of the capability of the banks.

REFERENCES

Agresti A, (1996): An Introduction to Categorical Data Analysis, john Wilsey And Sons

Aja-Nwachukwu I. (1993): "Banking stability and the Nigeria deposit insurance corporation (NDIC)", First Bank Review vol.2 No 4, pp. 10-15

CBN/NDIC (1995): Distress in the Nigeria Financial services industry: A CBN/NDIC collaborative study. Page publishers Yaba Lagos.

De juan A. (1991): "Does bank insolvency matter? And what to do about it?" EDI Working paper. Washington, D.C.; economic Development institute of the world Bank.

Ekpenyong D.B. (1994): "Financial Distress in Banks: Nature and Implications "The Nigerian Banker April-june, pp. 15-22

Ebhodaghe J.U. (1996): "Distress Management and prevention Strategies for the Nigerian Banking System (1997): "The Impact of failed Banks on the Nigeria Economy" NDIC Quarterly Vol.6 No 1&2, pp. 24-39.

Fagoyingbo, I.S, akimbo,R.Y., Ajibode, I.A.,(2013): Modeling Academic Risks of students in a polytechnic system with the use of discriminant analysis, Progress in Applied Mathematics, Vol. 6, No.2, 2013, pp. 59-69.

Festus, A.F. and Adeniran, F.S. (2013): Strategic Planning and Performance: Catalyst For Sustainability and Stability In The Nigerian Financial Sector. European Scientific Journal.

Fisher R.A. (1936): The use of Multiple measurements in taxonomic problems, Ann. Eugenics 7, 179 – 188.

Gavin M. and Hausmann R. (1996): "The roots of Banking crises: The macroeconomic context" .Inter-American Development Bank, washington, D.C. Gilbert R.A. and

Kochi L.A. (1994): “Local Economic Effects of Bank Failures” in Blinder Banks structure and competition. Megraw Hill Company.

Miguel, A. S. and Charles, G. (2009): Banking stability measures (IMF working paper), WP/09/4

Mamman H. and Sunday A.D. (1994): “Banks’ Management issues and restoring the health of Nigeria banks through improving the quality of management/employees NDIC quarterly Vol.4. No.4, pp 56-68.

Miguel, S. and Charles, G. (2010): Distress Dependence and Financial Stability. Central Bank of Chile Working Paper.

Mishkin F.S. (1997): “Understanding Financial Crises: A Development country perspectives ”Annual World Bank conference on Dev. Econs 1996 IBRD/The World Bank, Washington D.C. USA, pp. 29-61.

Nagalakshini, G.S. (2015): Global impact of Banking and Insurance. International Journal of Scientific Research and Education. Vol.(3) no. 10.

Obadan, M.I. (1997): “Financial Institutions and Economic Development (2) Business Ties 20, October, pp. 5 – 9.

Xisong, J., Francisco, A., and Nadal, D. (2013): Banking Systemic Vulnerabilities: A tail-risk dynamic CIMDO approach. Journal of Financial Stability.