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PROPOSED STATISTICAL MODEL FOR IDENTIFYING AND STUDYING THE FACTORS AFFECTING THE OCCURRENCE OF FINANCIAL FAILURE CASE STUDY: EGYPTIAN ARAB REAL ESTATE BANK

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Abstract

This research aimed at proposing a statistical model for study and analysis of the most important variables that affect the financial performance of the Egyptian Arab Real Estate Bank, which may lead to financial failure.

The researcher uses a Cox regression model to choose the variables affecting the efficiency of financial performance of the Real Estate Banks in Egypt, in addition to estimating the average survival time.

Research results showed that the most important financial indicators affecting the occurrence of distress or financial failure in the Egyptian Arab Real Estate Bank are, respectively, rate of risky assets, employment rate of resource, rate of return on equity, earnings per share, employment rate of deposits, and capital adequacy ratio.

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Introduction

The activity of Egyptian Arab Real Estate Bank started under the Khedive decision on February 15, 1880 when the ‘Egyptian Land Bank’ was established in order to assist farmers and landowners in Egypt gain access to the financial support they needed to boost the productivity of their land, and increase the important role of the agricultural sector in the Egyptian economy.

In the years that followed the Egyptian Land Bank grew to become a prominent financial institution across the region, serving as a source of financial support for Arabs throughout the Middle East.

In response to the major upheavals witnessed in the region in the first half of the 20th Century, and in keeping with its stated role of serving the Arab people, the bank expanded its operations to Palestine.

In March 1946, the Arab Land Company - registered as an Egyptian Shareholding Company with its headquarters in Cairo and offices in Palestine - was established to lend support to the Palestinian agricultural sector in order to assist them in maintaining ownership of their lands and to increase their production capabilities.

With the occupation of Palestine shortly after its establishment, the Arab Land Company was prevented from maintaining its operations there and consequently relocated its offices to the Hashemite Kingdom of Jordan in 1951, where it continued to support the Palestinian agricultural sector and commenced its operations in the nascent Jordanian economy.

In 1954, a Presidential Decree was issued by renaming the Arab Real Estate Company to the Arab Real Estate Bank, based on the final decision of the Extraordinary General Assembly of the shareholders of this company held on 10 April 1954.

Since its inception 134 years ago, the bank has established itself as one of the largest banking entities in Egypt, specializing in real estate investments and trade finance. In Jordan and Palestine, the Egyptian Arab

Land Bank is a commercial bank providing a comprehensive range of corporate, retail and investment banking services.

The bank has 43 branches spread across Egypt, Jordan and Palestine along with a network of correspondents around the world and total assets of over 14 billion Egyptian pounds ($2.6 billion).

Although the bank has witnessed numerous internal and external changes during its long and successful history, its core aim remains the same - to provide innovative, accessible and valued financial support for the Arab economy as a whole.

Literature Review

There are many previous studies that addressed the issue of financial failure, including the study of Walid Mohammed Abdel-Aziz [2] entitled: Determinants of the Financial Failure in Business Establishments: Empirical Study on the Public Sector Companies for Engineering Industries, study of Ip and Koo [26] entitled: Formulation Framework: A Hybrid of Balanced Scorecard, SWOT Analysis and Quality Function Deployment, the study of Walid Zakaria Siam [33] entitled: Factors Affecting the Profitability of Commercial Banks in Jordan: Field Study, study of Hanselman [25] entitled: Risk Adjusted Return on Capital, and Karr [27] study: Performance Measurement in Banking.

From the previous studies, the researcher found that the Egyptian Arab Real Estate Bank suffers from many negative phenomena that affect its financial performance as the bank is suffering from decline in profit rates and a decline in profitability of stocks and a rise in loans relative to deposits, and in rates of risky assets, and increase in the proportion of bad debts, as well as the stiff competition with other specialized banks and investment banks, which affects the efficiency of the financial performance. The research problem lies in the following question:

What are the most important variables that cause a financial failure in the Egyptian Arab Real Estate Bank?

Research objective

This research aimed at proposing a statistical model for study and analysis of the most important variables that affect the financial performance of the Egyptian Arab Real Estate Bank, which may lead to financial failure.

Research importance

Arab Real Estate Bank is considered as one of the most important banks that specialized in the field of real estates in terms of its positive and effective role in development of housing projects. The importance of this research can also be identified through the following points:

1. To contribute in evaluation of the efficiency of financial performance of the bank.

2. Research importance will be elucidated through its results that give a clear picture to a decision-maker in the bank and enable him to identify and study the factors that may lead to financial failure.

Research limits

Research limits are as follows:

1. The time frame of this research is from 2002 to 2012 with quarterly research data.

2. The research is confined to the study of the Egyptian Arab Real Estate Bank.

Statistical analysis of data and inferring conclusions

Model variables

Dependent variable

Shareholders' equity/total assets which is a binary variable that it takes a (zero) value in the case of financial distress, while it takes a (one) value when the bank is not faltering financially.

Independent variables

Table 1. Independent variables of the Egyptian Arab Real Estate Bank

Variable	Code	Variable	Code
Returns/Assets	x_1	Interests paid/Total deposits	x_{13}
Returns/Shareholders equity	x_2	Net interests/Total assets	x_{14}
Dividends/Earnings per share	x_3	Deposits/Total assets	x_{15}
Net investments/Total assets	x_4	Revenues/Total assets	x_{16}
Total loans/Total assets	x_5	Stockholder equity/Deposits	x_{17}
Total cash/Total assets	x_6	Ratio of deposits employed	x_{18}
Returns on loans/Total revenues	x_7	Ratio of resources employed	x_{19}
Investment revenues/Total revenues	x_8	Total liabilities/Total assets	x_{20}
Cash/Total deposits	x_9	Rate of risky assets	x_{21}
Investments/Total deposits	x_{10}	Ratio of bad debts	x_{22}
Loans/Deposits	x_{11}	Ratio of capital coverage/Adequacy	x_{23}
Interest on loan/Total loan	x_{12}		

Statistical model applied in this research

The researcher uses a Cox regression model to choose the variables affecting the efficiency of financial performance of the Real Estate Banks in Egypt, in addition to estimating the average survival time of the Real Estate Bank in the banking market, as well as to predict the possibility of financial failure of the bank and prospect of leaving the banking market and so the decision makers in these banks could be able to take necessary measures to prevent the occurrence of financial failure of these banks. Cox regression model can be explained as follows.

Cox regression model

The aim of this model is to identify the causes of financial failure of the Egyptian Arab Real Estate Bank especially that they may lead to the possibility of its financial failure as well as predicting the time of this failure. This model also aims to discover the relationship between the state of financial failure and independent variables leading to the occurrence of financial failure.

Where this model focuses on studying the time between the onset of the financial distress of the Real Estate Bank and conditions of the same financial failure, this model also gives estimates for the effect of these variables on the occurrence of financial failure.

This model is also considered as one of the most important methods of statistical probability, which is used to determine the form of relationship between a group of independent variables which are known as risk factors and the dependent variable which is known as a hazard rate. In this study, the risk factors are manifested as a group of independent variables, which the researcher expects to have a significant effect on the efficiency of the financial performance of the Real Estate Banks. The hazard ratio represents the dependent variable related to the likelihood or proportion of the Real Estate Bank exposure to financial failure.

Where Cox model explains the resulting regression coefficients, if the regression coefficient is positive, it means that the risk is too high and that the possibility of financial failure is very close to the bank and that the bank is facing a great danger that threatens its entity and financial stability, but if the regression coefficient is negative, it means that the financial risk is low and that the risk of financial failure is far from the Real Estates Bank.

The following steps depicting Cox regression model

Cox regression model is designated "Proportional hazard model" which takes the following form:

$$h_i(t) = h_0(t)e^{G_I},$$

$$G_I = h_0 e^{(B1X1+B2X2+\cdots)},$$

$$h_i(t) = h_0 e^{\left(\sum_{j=1}^{p} B_J X_J\right)},$$

$h_i(t)$: the dependent variable expresses the hazard rate to which the bank is exposed (i) in the time period (t),

h_0: base line hazard function,

X, S: the proposed independent variables.

In order to reach the relative risk function and the exponential model, or what is known as a relative hazard function, the following functions should be identified:

1. Survival function

Survival function can be defined as the possibility of the bank survival for not less than (t) which can be expressed mathematically as follows:

$$S(t) = Pr(T > t),$$

(T) represents the accumulated time for the life of the Real Estate Bank during the period $(0, t)$ and to find the relationship between the probability function and survival function, we assume the life time (t) divided according to the cumulative probability function $[F(t)]$,

$$S(t) = 1 - Pr(T > t),$$

$$S(t) = 1 - F(t).$$

So, $[F(t)]$ is sometimes called a non-vital/living function which has the following characteristics:

1. Positive for all (t) values during the period $(0, t)$.

2. Continuous from the left side for all (t) values during the period $(0, t)$.

3. Non-increasing function for all (t) values.

4. Its value lies between zero and one because:

$$\lim_{t \to \infty} S(t) = 0,$$

$$S(0) = 1.$$

And the following figure illustrates this:

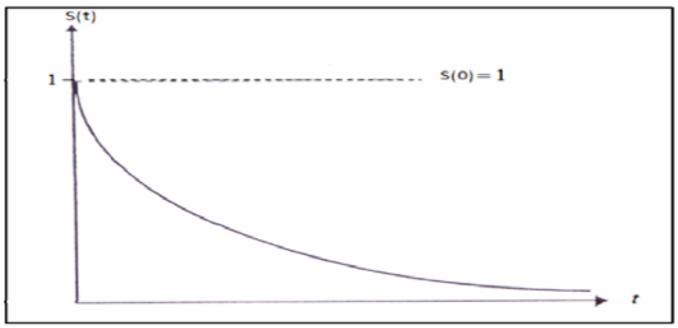

Figure 1. Illustrates the survival function.

Survival function curve

The probability density could be found from the survival function as follows:

$$S(t) = 1 - F(t),$$

$$\frac{ds(t)}{dt} = -f(t),$$

$$F(t) = -S\backslash(t).$$

2. Hazard function

It is the probability that the bank under study may fail during the period $[t, t + \Delta t]$, note that it may come without failure for the period (t), and it is also known as the instantaneous failure rate or the force of failure, and the conditional probability can be expressed mathematically as following:

$$h(t) = \lim_{\Delta t \to 0}\left[\frac{Pr\{t < t + \Delta t \backslash T > t\}}{\Delta t}\right],$$

$$h(t) = \lim_{\Delta}\left[\frac{F(t + \Delta t) - F(t)}{\Delta t S(t)}\right],$$

$$h(t) = \frac{dF(t)}{dt} \times \frac{1}{S(t)}$$

and that the relationship between the failure function $f(t)$ and the survival function $S(t)$ with a hazard function is as follows:

$$h(t) = \frac{f(t)}{S(t)},$$

$$h(t) = \frac{f(t)}{1 - F(t)},$$

$$h(t) = \frac{dF(t)}{1 - F(t)},$$

by taking the integration of both terms we get the following:

$$\int_0^1 h(t)\,dt = \int_0^1 \frac{f(t)}{1 - F(t)}\,dt,$$

$$\int_0^1 h(t)\,dt = -\ln[1 - F(t)]$$

$$= -\ln[1 - F(t)]$$

$$= -\int_0^1 h(t)\,dt = \ln[1 - F(t)]$$

and after taking the exp of both terms:

$$\exp\left(-\int_0^1 h(t)\,dt\right) = [1 - F(t)],$$

$$S(t) = [1 - F(t)],$$

therefore, the survival function can be as follows:

$$S(t) = \exp\left(-\int_0^1 h(t)\,dt\right).$$

3. Relative risk function

They are those functions that have a relative hazard, i.e., that the Real Estate Banks under study have proportionate risk functions with each other, and all the different life functions can be developed to relative risk functions in different ways, and the most important risk functions are:

$$h(t) = h(0)\exp(B_1x_1 + B_2x_2 + B_3x_3 + \cdots + B_px_p)$$

and by dividing both terms of the function $h(0)$ we get the following form:

$$\frac{h(t)}{h(0)} = \exp(B_1x_1 + B_2x_2 + B_3x_3 + \cdots + B_px_p)$$

and by taking the ordinary logarithm $\log e$ of both terms of the function we obtain the following form:

$$\log_e \frac{h(t)}{h(0)} = B_1x_1 + B_2x_2 + B_3x_3 + \cdots + B_px_p.$$

As the model parameters $B_1, B_2, B_3, ..., B_p$ will be estimated by (MLE) with (Newton-Raphson method) method. In this method (MLE), the estimates that venerate $L(B)$ and bring about the following formula will be selected:

$$\frac{\partial L(B)}{\partial B_i} = \text{zero}.$$

And thus makes $\log L(B)$ the largest possible one and of the characteristics of logarithm function:

$$\frac{\partial \log_e(B)}{\partial B_i} = 0.$$

These parameters represent the expected relative variation in the dependent variable (risk ratio) as a result of the relative change in the independent variables (risk factors). Parameters of the signs of independent variables are explained as follows:

If the coefficient of the independent variable is positive, then it means that the risk is too high and that the possibility of financial failure of the bank is imminent, and that the bank is facing a great danger that threatens its entity and financial stability, but if the coefficient of the independent variable is negative, then it means that the financial risk is low and that the Real Estate Bank will not be exposed to the risk of financial failure.

Cases of risk function

The first case

Assuming no correlation between survival times:

In this case, Cox supposed the presence of a constant survival time, and for acquiring the model we divide both terms of the equation by $h_0(t)$, and by taking the usual logarithm we get the following equation:

$$\log_e \frac{h_i^{(t)}}{h_0^{(t)}} = B_1 x_1 + B_2 x_2 + \cdots + B_p x_p.$$

The previous function shows that the logarithm of the relative risk of the bank (i) is a linear function in the independent variables, and this case is used for comparing between the rates of the risk to which two groups of Real Estate banks are exposed, where the rate of the relative risk as a percentage or possibility of financial failure of the Real Estate Bank can be calculated at any period of time in the presence of a specific set of independent variables, to the likelihood of failure until the independent variables are at their averages, and in this case the equation becomes as follows:

$$\log e\left[\frac{h_{i(t)}}{h_{0(t)}}\right] = B_1(x_i - \bar{x}) + \cdots + B_p(x_{ip} - \bar{x}),$$

where

$\bar{x}$: is the average of the independent variables,

$h_0(t)$: is a risk function when all the independent variables are at their average value, and (MLE) method is used to estimate the parameters. It is also considered as a conditional probability of failure, where it is when a failure F occurs at time $t(i)$, provided that it occurs in the risk value of $R(ti)$, the probability of failure of the bank (i) is:

$$p[F_t / R(ti)] = \frac{\exp^{\left(\sum_{j=1}^{p} B_j x_j\right)}}{\sum_{j \in R(ti)} \exp^{\left(\sum_{j=1}^{p} B_j x_j\right)}}.$$

And thus the logarithm of the conditional maximum likelihood function required is:

$$LL(B = (LL(B))) = \sum_{i=1}^{k} \sum_{j=1}^{p} B_i x_{ji}$$

$$- \sum_{i=1}^{k} \log\left[\sum_{j \in R(ti)} \exp\left(\sum_{j=1}^{p} B_j x_{ji}\right)\right].$$

The second case

Existence of a correlation between survival times:

In this case, we assume the existence of equal values in the times of survival, and Cox proposed a model that can be applied when the time is staying sporadic variable, and the probability of a certain Real Estate Bank failure falling into $R(ti)$ risk category with equal survival times is:

$$p[F_i / R(ti)] = \frac{\exp^{(B0Z1i + B2Z2i + \cdots + B0Zpi)}}{\sum_{t \in R(ti)} \exp^{(BiZ1i + \cdots + BpZpi)}},$$

F_i: is occurrence of financial failure,

Zti: is a total independent variable (Xi, s) for the observations of frequent failure times (mi) and also $t(i)$ so the maximum conditional function of the logarithm for the equation shall be as follows:

$$LL(B) = \sum_{i=1}^{k} (B1Zit + \cdots + BpZpi)$$
$$- \sum_{i=1}^{k} \log\left[\sum_{i=1} \exp(B1Zit + \cdots + BpZpi)\right].$$

We use the method of the gradient slope to estimate the parameters and apply the method of forward gradient to select the variables included in the model. Insertion will be made in accordance with the variable that had the largest possible logarithm value, and in every step, the likelihood ratio test will be selected to determine whether the last selected variable has added a significance to the model which includes previously selected variables, that by using the following selection:

$$[LL(B1, \ldots, B(k-1)) - LL(B1 \cdots Bk)] = -2\chi^2.$$

The test follows the distribution of χ^2 with a single degree of freedom.

Test of model significance

The "likelihood ratio test" is used to examine the model significance as a whole.

$$H_0 : b_1 = b_2 = b_3 = \cdots = b_p = 0,$$

$$H_a : b_1 \neq b_2 \neq b_3 \neq \cdots \neq b_p \neq 0.$$

The ratio of the maximum likelihood ratio for the model as a whole is calculated through a value of χ^2 as follows:

$$\chi^2 = -2 \log_e \left[\frac{L_0}{L_i}\right] = -2[\log_e L_0 \log_e L_i],$$

χ^2: the calculated χ^2 value,

$\log_e L_0$: the maximum likelihood logarithm of the model in the absence of independent variables.

That is, all parameters = zero except the constant.

$\log_e L_i$: the maximum likelihood logarithm of the model in existence of independent variables.

That is to say, this model contains all the independent variables.

Thus, the decision will be:

If $\chi_e^2 \leq \chi_1^2(1- \propto;\ p - q)$, then conclude H_0.

If $\chi_e^2 > \chi_1^2(1- \propto;\ p - q)$, then conclude H_a.

Examining the significance of each independent variable separately

(Wald test) is used to examine the significance of each variable separately, as well as to clarify the degree of importance of independent variables, so that the higher Wald value indicates the importance of the variable and vice versa and during this test, we assume that the parameters of independent variables are equal to zero as follows:

$$0 =: b_i H_0,$$

$$0 \neq: b_i H_a,$$

$$W = \frac{b_i}{\sqrt{[SE(b)]^2}}.$$

The resulting ratio will follow the normal standard distribution, and this test is based on the maximum likelihood function of the binary dependent variable.

Findings of applying Cox model on the data of the Egyptian Arab Real Estate Bank

The researcher depends on applying Cox regression model, so as to identify the most important financial indicators affecting the occurrence of the financial failure to the Egyptian Arab Real Estate Bank. The data was analyzed by using the software package known as (SPSS), relying on the results of applying the forward omission method and the results were as follows:

Statistical tests proved the significance of 9 independent variables that reflect the financial indicators affecting the occurrence of the financial failure of the Egyptian Arab Real Estate Bank, as shown in the following table:

Table 2. Results of applying the Cox regression model using forward deletion method

Variables		B	SE	Wald	df	Sig.	Exp(B)
x_4	Net investment/Total assets	-2.801	0.692	16.401	1	0.000	0.061
x_{21}	Rate of risky assets	1.606	0.397	16.378	1	0.000	4.983
x_{20}	Total liabilities/Total assets	-1.554	0.468	11.023	1	0.001	0.211
x_{19}	Ratio of resources employed	0.765	0.308	6.172	1	0.013	2.149
x_2	Returns/Stockholders equities	0.216	0.087	6.124	1	0.013	1.241
x_3	Dividends	0.767	0.335	5.250	1	0.022	2.154
x_{18}	Ratio of deposits employed	0.915	0.465	3.871	1	0.049	2.497
x_{11}	Loans/Deposits	-1.709	0.902	3.591	1	0.058	0.181
x_{23}	Ratio of capital adequacy	1.311	0.706	3.445	1	0.003	3.709

The above table indicated the following:

1. Statistical tests proved the significance of 9 independent variables at a significance level of (5%), which represent the most important financial indicators affecting the occurrence of the financial failure of the Real Estate Bank. These variables are as follows:

x_4: net investments/total assets

x_{21}: rate of risky assets

x_{20}: total liabilities/total assets

x_{19}: ratio of resources employed

x_2: returns/shareholders equity

x_3: earnings per share (dividends)

x_{18}: ratio of deposits employed

x_{11}: total loans/total deposits

x_{23}: ratio of capital adequacy.

2. The significance of variables parameters are shown through applying the (Wald) test as well as (P-value), as the $(P < 0.05)$ is used for all variables. In the light of (Wald) test, it becomes obvious that the net investments/total assets are one of the most important financial indicators affecting the occurrence of financial failure, followed by the rate of risky assets, then the ratio of total liabilities to the total assets, and finally the variable of total loans/total deposits in last rank in terms of degree of importance, as the importance of the variable increases with a higher (Wald) value.

3. According to the estimated indicators of parameters, the expected future financial performance of the Egyptian Arab Real Estate Bank of Egypt is identified as follows:

- The *negative factor* means that the expected future performance is optimal as the bank's exposure to the risk of distress or bankruptcy decreases.

- The *positive factor* means that the expected future performance of the bank is poor where the bank's exposure to the risk of distress or bankruptcy increases.

4. From the above mentioned table and in the light of the signs of the estimated coefficients obtained from the results of applying the Cox regression model, it is evident that the variables: net investment/total assets, total liabilities/total assets, total loans/total deposits are of the variables that do not expose the bank to the risk of financial distress, while the variables: rate of risky assets, resources employment rate, the rate of return on equity, earnings per share (dividends), the deposits employment rate, capital adequacy ratio are of the variables that expose the bank to the event of distress or financial failure.

5. Based on the previous findings, the relative risk function of the Egyptian Arab Real Estate Bank is:

$$\frac{h(t)}{h(0)} = \exp(0.061x_4 + 4.983x_{21} + 0.211x_{20} + 2.149x_{19} + 1.241x_2 + 2.154x_3 + 2.497x_{18} + 0.181x_{11} + 3.709x_{23}).$$

6. The logarithm image of the risk function is:

$$\log_e \frac{h(t)}{h(0)} = -2.801x_4 + 1.606x_{21} - 1.554x_{20} + 0.765x_{19} + 0.216x_2 + 0.767x_3 + 0.915x_{18} - 1.709x_{11} + 1.311x_{23}.$$

7. Statistical significance of the model as a whole is verified from the findings of the maximum likelihood ratio (–2 log likelihood) and test value of (chi-square) as well as the level of significance value as indicated in the following findings:

Table 3. Findings of the model significance test

Step	Overall (score)				Change from previous step			Change from previous block		
	-2 log likelihood	Chi-square	df	Sig.	Chi-square	df	Sig.	Chi-square	df	Sig.
1	103.58	117.01	23	0.000	106.81	12	0.000	106.82	23	0.000
7	107.25	99.86	9	0.000		12		103.15	9	0.000

The following figure illustrates the risk function at the averages of independent variables, and the figure shows the ratio of the cumulative risk to which the Egyptian Arab Real Estate Bank is exposed through time, as the degree of risk decreased during the initial periods of time and then it increased with a passage of time.

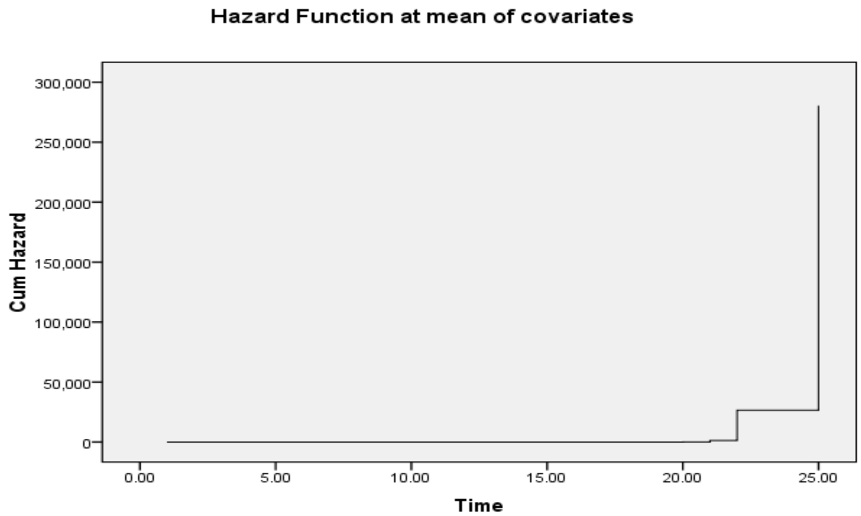

Figure 2. Cumulative hazard function curve of the Real Estate Bank.

Results and Recommendations

First: research results

1. Research results showed that the most important financial indicators affecting the occurrence of distress or financial failure in the Egyptian Arab Real Estate Bank are, respectively:

- rate of risky assets (x_{21})
- ratio of resources employed (x_{19})
- returns/shareholders equity (x_2)
- earnings per share (x_3)
- ratio of deposits employed (x_{18})
- capital adequacy ratio (x_{23}).

2. The results showed that the model expressing the relative risk function of a Cox regression model to the Egyptian Arab Real Estate Bank is:

Second: recommendations

$$\frac{h(t)}{h(0)} = \exp(0.061x_4 + 4.983x_{21} + 0.211x_{20} + 2.149x_{19} + 1.241x_2$$
$$+ 2.154x_3 + 2.497x_{18} + 0.181x_{11} + 3.709x_{23}).$$

In the light of the research findings, the researcher recommends the following:

1. The need to re-conduct the same study on specialized and commercial banks.

2. The need to apply the proposed standard model for the purpose of achieving the following:

- Predict the banking distress before it occurs within a period that allow the banking management and authorities and supervisory agencies to take the necessary actions before they aggravate or become critical.

- Achieve the objectives of a clear accounting disclosure which reflects the importance of principles and rules of measurement used in the forecasting process.

- Factual and concrete diagnosis and analysis of banking performance over a period of time allowed to monitor and follow up and develop this performance and to serve the objectives of continuity.

3. The surveillance and control authorities had to conduct the financial analysis of the final statements for the banks and apply the proposed model to precociously predict the situation of those banks so as to be able to take the necessary corrective decisions for this bank.

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