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# Bank Financial Statement Management using a Non-Preemptive Goal Programming model

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**Abstract**
The six goals of one of the premier banks in Malaysia, namely asset accumulation, liability reduction, equity wealth, earning,profitability and optimum management items in the financial statement were examined. The data are collected from the bank's annual report and banks cope from 2010 until 2014. The non-preemptive goal programming model is developed to find an optimal solution for six goals by simplex method using Microsoft Excel. The result shows that all six goals are fully achieved.Results compared between solutions using LINGO software version 11. The proposed model can be used as a guideline for financial institutions in making decisions and develop strategies to deal with various economic scenarios.

**Keywords:** assets; earning; goal programming; liability; management; profitability

## 1. Introduction

Banks must maximise profit while also monitoring and minimising various risks in order to maintain an effective asset-liability management. Asset and liability management, according to Tektas et al.[22], is a multidimensional process that necessitates cogent interaction between various dimensions. Asset and liability positions will determine preferred liquidity and desired results. In order to use money as effectively as possible, banks must develop strategies and evaluate various objectives, including reducing risk and ensuring security.

According to Machiel [9], effective management of a bank's balance sheet results in the goal of maximising returns while also taking into account competing goals like minimising risk, subject to managerial and regulatory restraints. By maximising profits, ensuring liquidity, and achieving desired levels, Angela [21] proposed that banking harmony could be attained.The dynamic environment increases uncertainty and potential conflicts of interest, and the incomplete information prevents the development of reliable mathematical tools or solution analyses tailored to the decision-maker's preferences.Multiobjective goals cannot be analysed by simple linear programming. However, using a goal programming model would allow banks to gauge or assess these various objectives.

In order to analyse four different types of goals, including profitability, capital adequacy, liquidity, and loan-deposit ratio, Forster and Dince [6] used a goal programming model. For the management of banks' assets and liabilities that were primarily denominated in foreign currencies used a two-stage goal programming model. Three goals net profit maximisation, capital adequacy ratio, and risky asset-capital ratio minimization were discussed by Eatmen and Sealey[4].

We willl look at six of Maybank's objectives, one of Malaysia's top banks. The objectives that need to be looked at are (1) asset accumulation, (2) liability reduction, (3) equity wealth, (4) earning and

(5) profitability, and (6) the best management item on the financial statement. The structure and variations in the proportion of items in the chosen Maybank financial statement will be examined using the non pre-emptive method of goal programming. The following is a breakdown of the remaining sections of the paper: a literature review, methodology, results and discussion, followed by a conclusion and recommendations.

## 2. Literature Review

In the field of assets and liability, deterministic linear programming was invented by Hammers and Charnes in 1961. Their model determined the best portfolio for a specific bank over a period of time while taking bank examiner requirements into account.However, the decision-makers occasionally listed multiple criteria in their managerial issues, making it impossible for the linear programming model to combine all of the criteria at once. As a result, the goal programming technique has been developed to address problems with multiple objectives. To analyse multiple conflicting objectives while taking the decision maker's constraints and preferences into consideration, Ignizio [32] proposed a goal programming model.

Goal programming was used in the banking and financial institutions fields by Giokas and Vassiloglou [33], Seshadri et al. [2], Agarana, Bishop, and Odetunmibi [13], they created their bank models using the information from the financial statements. In addition, a goal programming model of asset liability management for Greek commercial banks. The objectives included increasing returns, minimising risk, maintaining liquidity and solvency at a desirable level, and increasing deposits and loans.

The goal programming model can be improved and combined with different approaches. Prior to using it in the goal programming technique, Tunjo and Zoran [34] developed the linearization of fraction Meanwhile, in the application of bank financial statement management, Bushra et al.[3] developed a goal programming model to examine six goals, namely asset accumulation, liability reduction, shareholders' wealth, earning, profitability and optimum management of all items in the financial statement by using the weight method and pre-emptive method.

## 3. Weighted Goal Programming model

This paper suggested the weights method to construct the model. The method or algorithms convert multiple goals into a single objective function. This technique is known as a goal programming technique by Taha [18]. A goal programming model was developed in this study to obtain the optimal solution of goals. The goals and constraints must be involved to formulate the model.The objective function of the weight goal programming model is a single objective function of the weighted sum of the functions representing the goals of the problems. The model is given as:

Minimize Z = $\sum_i^m w_i^- d_i^- + w_i^+ d_i^+$

Subject to $\sum_i^n a_{ij}\, x_{ij} + d_i^- d_i^+$ (i=1,2,…m)

$x_{ij}, d_i^-, d_i^+ \geq 0$, $w_i > 0$ (i=1,2, ... ,m ; j=1,2,3, … ,n)

where, $w^-$, $w^+$ represent the weights of the goal programming associated with the negatives and the positives deviational variables $d_i^+$ and $d_{\bar{i}}$ respectively. These deviational variables signify how far the decision is from the goal and how much the decision has exceeded the goal respectively. In addition, each objective has a goal or a target value which given $b_i$, and that is required to be achieved. As for the undesirable deviations ($d = \mathrm{d}^-, \mathrm{d}^+$), their goals are achieved by minimizing the goals $bi$ through the use of the achievement function z. A deviational variable represent the deviation or the distance between the level of aspiration and the actual achievement of a goal. Thus, the variable deviations $d$ are replaced by two variables: $d = \mathrm{d}^-, \mathrm{d}^+$. The $d$ deviational variable is ensured to get positive values

and that the constraints ensure that one variable of deviation will always have a zero value. As for the deviation's variables have to be grouped in a mathematical form called achievement function with a goal of minimizing these deviational variables to ensure a solution that is desired and at a satisfactory level.

### 3.1 The Modified Simplex Method

In this paper, applying the simplex method to this formulation by using Excel yields an optimal solution for the bank financial statement management problem.

The simplex method is a popular algorithm for solving linear programming problems. It is an iterative algorithm that starts with a feasible solution and then repeatedly improves the solution until it reaches an optimal solution. The simplex method can be implemented in a variety of software packages, including Microsoft Excel.

In this paper, we present a method for using Microsoft Excel to solve linear programming problems using the simplex method.The result obtained show that this method is a powerful tool for solving linear programming problems.

### 3.2 Model Application and Formulation

Maybank is selected as the case study in this paper. The data of financial statement including total assets, liabilities, total equity, earning and profit are obtained from the Maybank annual statement and bank scope. The details are summarized in Table 1.

**Table 1:** Summarized Maybank financial statement from 2010 to 2014 (RM' million).

| Item (Goal) | Year | | | | | Total |
|---|---|---|---|---|---|---|
| | 2010 | 2011 | 2012 | 2013 | 2014 | |
| Assets | 336,700 | 451,632 | 494,757 | 560,319 | 640,300 | 2,483,708 |
| Liability | 308,035 | 415,747 | 450,942 | 512,576 | 585,559 | 2,272,859 |
| Equity | 28,664.94 | 32,470.27 | 43,814.80 | 47,742.60 | 54,741.18 | 207,433.78 |
| Profit | 3,818 | 2,587 | 5,746 | 6,552 | 6,716 | 25,419 |
| Earnings | 290,795.20 | 376,590.70 | 425,636.10 | 479,248.80 | 551,794.50 | 2,124,065.30 |
| Total | 968,013 | 1,279,027 | 1,420,896 | 1,606,438 | 1,839,111 | 7,113,485.08 |

Table 2 gives a summary of Maybank's financial statements in coded values with weights between 2010 and 2014 in RM trillion. The purpose of coding the values is to enable analysis with small figures.

**Table 2:** Coded values for summarized Maybank financial statement from year 2010 to 2014 (RM' trillion).

| Item (Goal) | Year | | | | | Total |
|---|---|---|---|---|---|---|
| | 2010 | 2011 | 2012 | 2013 | 2014 | |
| Assets | 0.3367 | 0.4516 | 0.4948 | 0.5603 | 0.6403 | 2.4837 |
| Liability | 0.308 | 0.4157 | 0.4509 | 0.5126 | 0.5856 | 2.2729 |
| Equity | 0.0287 | 0.0325 | 0.0438 | 0.0477 | 0.0547 | 0.2074 |
| Profit | 0.0038 | 0.0026 | 0.0057 | 0.0066 | 0.0067 | 0.0254 |
| Earnings | 0.2908 | 0.3766 | 0.4256 | 0.4792 | 0.5518 | 2.1241 |
| Total | 0.968 | 1.279 | 1.4209 | 1.6064 | 1.8391 | 7.1135 |

The decision variables are:

$x_1$= the amount of financial statement in year 2010

$x_2$= the amount of financial statement in year 2011

$x_3$= the amount of financial statement in year 2012

$x_4$= the amount of financial statement in year 2013

$x_5$= the amount of financial statement in year 2014

The goal constraint;

$0.3367x_1 + 0.4516x_2 + 0.4948x_3 + 0.5603x_4 + 0.6403x_5 \geq 2.4837$ (asset accumulation constraint)

$0.3080x_1 + 0.4157x_2 + 0.4509x_3 + 0.5126x_4 + 0.5856x_5 \leq 2.2729$ (liability constraint)

$0.0287x_1 + 0.0325x_2 + 0.0438x_3 + 0.0477x_4 + 0.0547x_5 \geq 0.2074$ (equity wealth constraint)

$0.0038x_1 + 0.0026x_2 + 0.0057x_3 + 0.0066x_4 + 0.0067x_5 \geq 0.0254$ (profit constraint)

$0.2908x_1 + 0.3766x_2 + 0.4256x_3 + 0.4792x_4 + 0.5518x_5 \geq 2.1241$ (earning constraint)

$0.9680x_1 + 1.2790x_2 + 1.4209x_3 + 1.6064x_4 + 1.8391x_5 \geq 7.1135$ (financial statement constraint)

$x_1, x_2, x_3, x_4, x_5, d_1^+, d_2^+, d_3^+, d_4^+, d_5^+, d_6^+, d_1^-, d_2^-, d_3^-, d_4^-, d_5^-, d_6^- \geq 0$ (non-negativity constraint)

Objective function;

Minimize: P1($d_1^-$ ) + P2($d_2^+$ ) + P3($d_3^-$ ) + P4($d_4^-$ ) + P5($d_5^-$ ) + P6(2$d_6^-$ )

Minimum: P1($d_1^-$ ) : Maximize the total assets + P2($d_2^+$ ) : Minimize the liabilities + P3($d_3^-$ ) : Maximize the equity wealth + P4($d_4^-$ ) : Maximize the total earning + P5($d_5^-$ ) : Maximize the profitability + P6($d_6^-$ ) : Maximize the proportion of the values of the items in the financial statement

## 4. Results and Discussion

In this paper, Simplex method by using Microsoft Excel is used to obtain the optimal solution.Applying the simplex method to the formulation yields an optimal solution.

**Table 3:** Final Tableau of Simplex method.

**Final GP Simplex Tableau**

| Cj | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 2 | RHS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VB | X1 | X2 | X3 | X4 | X5 | d1+ | d2+ | d3+ | d4+ | d5+ | d6+ | d1- | d2- | d3- | d4- | d5- | d6- | |
| d6+ | -0.000914306 | 0.018107 | 0.000288 | 0.002920209 | 0 | -2.87225 | 0 | 0 | 0 | 0 | 1 | 2.872247 | 0 | 0 | 0 | 0 | -1 | 0.020300828 |
| d2- | 6.38451E-05 | 0.00268 | -0.00163 | 0.000165704 | 0 | 0.914571 | -1 | 0 | 0 | 0 | 0 | -0.91457 | 1 | 0 | 0 | 0 | 0 | 0.001379275 |
| d4+ | -0.000276823 | 0.002125 | -0.000522 | -0.000737108 | 0 | -0.01046 | 0 | 0 | 1 | 0 | 0 | 0.010464 | 0 | 0 | -1 | 0 | 0 | 0.000589052 |
| X5 | 0.525847259 | 0.7052944 | 0.7727628 | 0.875058566 | 1 | -1.561768 | 0 | 0 | 0 | 0 | 0 | 1.5617679 | 0 | 0 | 0 | 0 | 0 | 3.878962986 |
| d3+ | 6.38451E-05 | 0.0060796 | -0.00153 | 0.000165704 | 0 | -0.085429 | 0 | 1 | 0 | 0 | 0 | 0.0854287 | 0 | -1 | 0 | 0 | 0 | 0.004779275 |
| d5+ | -0.000637482 | 0.0125814 | 0.0008105 | 0.003657317 | 0 | -0.861784 | 0 | 0 | 0 | 1 | 0 | 0.8617835 | 0 | 0 | 0 | -1 | 0 | 0.016311776 |
| Zj | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cj-Zj | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 2 | |

Table 3 shows $Z_j$ =0 means all the goals are fully achieved and the optimal solution is generated.The findings of goal achievement is illustrated in Table 4 below.

**Table 4:** Goals achievement.

| Goals Priority | Goals Achievement |
|---|---|
| P1 | Fully Achieved |
| P2 | Fully Achieved |
| P3 | Fully Achieved |
| P4 | Fully Achieved |
| P5 | Fully Achieved |
| P6 | Fully Achieved |

Table 4 shows that P1=0, P2=0,P3=0, P4=0, P5=0 and P6=0.Therefore, all goals are fully achieved and the optimal solution is generated.

**Table 5:** Result of deviational variables.

| Goals Priority | Negative Deviation Variables $(d_i^-)$ | Positive Deviation Variables $(d_i^+)$ |
|---|---|---|
| P1 | 0 | 0 |
| P2 | 0.0013793 | 0 |
| P3 | 0 | 0.0047793 |
| P4 | 0 | 0.0005891 |
| P5 | 0 | 0.0163118 |
| P6 | 0 | 0.0203008 |

Table 4 shows the value positive deviation and negative deviation for P1 until P6. The first priority, P1 is to maximize the total assets of the bank. The result shows that the value for negative deviation, $d_1^-$ is zero. Therefore, the goal is fully achieved and positive deviation, $d_1^+$ is also zero, meaning that the total asset of the bank does not change, which is equal to RM2,483,708 million for 5 years. For goal of liability reduction (P2) , the values of $d_2^-$ is 0.13793×$10^{-2}$ and $d_2^+$ are zero, which indicates that the total liabilities for 5 years can be decreased by RM0.0014 trillion per year,which is equal to RM2,272,859 million. For goal 3, P3 the value of $d_3^-$ is zero while the value of $d_3^+$ is 0.47793×$10^{-2}$. This shows that the equity wealth goal (P3) achieved and the total equity of the bank can be increased by RM0.0048 trillion per year. Besides, the goal of maximizing the profitability (P4) ,since the value of $d_4^-$ is zero and the value of $d_4^+$ is 0.17567891×.$10^{-2}$ This indicates that the profitability of a bank can be increased by RM0.0017 trillion per year. Besides, the value of $d_5^-$ is zero and the value of $d_5^+$ is 0.163118×$10^{-1}$, so it can be concluded that maximizing earning goal (P5), the earning of the bank can be increased by RM0.016 trillion per year. Lastly, the goal of maximizing the proportion of the values of the items in the financial statement, the value of $d_6^-$ is zero and the value of $d_6^+$ is 0.203008×$10^{-1}$.This shows that the proportion of the values of the items in the financial statement can be increased by RM0.02 trillion per year.

The result were compared to research paper, Bushra Abdul Halim [2].LINGO Software version 11 is used which is the combination of weights and pre-emptive method to obtain the optimal solutions.The findings of goal achievement are shown in Table 6 below.

**Table 6:** Result of deviational variables by using LINGO Software version 11

| Goals Priority | Negative Deviation Variables | Positive Deviation Variables |
|---|---|---|
| P1 | 0 | 0 |
| P2 | 0 | 0 |
| P3 | 0 | 0.00221 |
| P4 | 0 | 0.00176 |
| P5 | 0 | 0.01631 |
| P6 | 0 | 0.02027 |

Therefore, Simplex method by using Microsoft Excel,which uses only weighted goal programming model,the result is much better compared to result obtained by using LINGO Software version 11 that applied the combination of weighted and pre-emptive goal programming model.It is because, the simplex method, which uses the liabilities constraint, is better if we want to minimize $d_2^-$. This is because the liabilities constraint takes into account the bank's total income, expenses, and borrowing and lending limits. This means that the first method will produce a solution that is more realistic and achievable than the second method.The second method, which does not achieve the value of $d_2^-$, is likely to produce a solution that is not realistic or achievable. This is because the second method does not take into account the bank's borrowing and lending limits. This means that the second method may produce a solution that requires the bank to borrow more money than it is able to borrow. In conclusion, the first method is better if we want to minimize $d_2^-$and the second method, which is simpler but less realistic and achievable.

**Conclusion**

In this paper, All six of the examined goals have been attained, according to the model's findings. This demonstrates Maybank's strong financial performance. However, there are four objectives that can be changed to raise the aspiration level which is equity wealth, earnings, profitability, and the percentage of the values of the items in the financial statement. A bank can use the suggested model as a guide when making decisions and planning a course of action to handle various economic scenarios. The suggested model can also be a tool or a system of solutions that aids banks or other financial institutions in developing a blueprint for their plans and identifying the ideal benchmark they hope to reach in the future.

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