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Bank Financial Statement Management using a 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 bankscope from 2010 until 2014. The goal programming model is developed to find an optimal solution for six goals by using the LINGO Software version 11. The result shows that all six goals are fully achieved. The proposed model can be used as a guideline for financial institutions in making decisions and develop strategies to deal with various economic scenarios.

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*Keywords:*asset; earning; equity; goal programming; liability; management; profitability

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1. Introduction

An efficient asset–liability management requires banks to optimize profit as well as monitor and reduce various risks. Tektas et al. (2005) stressed that asset and liability management is a multidimensional process requiring coincident interaction among different dimensions. The position of asset and liability will determine liquidity preference and desired outcomes. Thus, banks have to create strategies to make efficient use of funds and analyze the various goals such as minimizing risk and ensure security.

Based on Machiel (2011), efficient management of bank's balance sheet leads to the goal of maximizing returns and coincidentally taking into account conflicting goals such as minimizing risk, subject to regulatory and managerial limitation. Angela (2008) proposed that banking harmony could be achieved by actualizing profit maximizing liquidity and reaching desired liquidity.

The dynamic environment builds uncertainty and conflict of interest while fragmented information makes it impossible to build a set of trustworthy mathematical tools or solution analysis for the decision-maker's preferences. Simple linear programming is not capable of analyzing multi-objective goals. Using a goal programming model, however, would enable banks to measure or analyze these various goals.

Forster and Dince (1977) used a goal programming model to analyze four types of goals such as profitability, capital adequacy, liquidity, and loan–deposit ratio. Korhonen (1987) utilized a two-stage goal programming model for the management of foreign currency dominated asset and liabilities of the banks. Eatmen and Sealey (1979) deliberated upon three objectives, namely net profit maximizing, capital adequacy ratio and risky asset–capital ratio minimization.

We will examine six goals of Maybank, one of the premier banks in Malaysia. The goals to be examined are: (1) asset accumulation, (2) liability reduction, (3) equity wealth, (4) earning and (5) profitability and (6) optimum management item on the financial statement. We will use the pre-emptive method of goal programming to analyze the structure and variations in the proportion of items in the selected Maybank financial statement. The remaining parts of the paper are outlined as follows: literature review, methodology, result and discussion, followed by conclusion and recommendations.

2. Literature Review

Some mathematical programming has been applied to assist the management of banks in their financial planning. Chambers and Charnes (1961) pioneered the development of a deterministic linear programming model in assets and liability. The optimal portfolio for an individual bank over some periods by considering the requirements from bank examiners was determined in their model.

However, sometimes, the decision makers stated multiple criteria in their managerial problems; hence, the linear programming model is unable to combine all the criteria simultaneously. Therefore, the goal programming technique has been introduced in order to solve multi-objective problems. Ignizio (1976) proposed a goal programming model to analyze multiple conflicting objectives while taking into account the constraints and preference of the decision maker. Since then, goal programming techniques has been applied to many areas such as agriculture planning (Hassan et al., 2013), scheduling (Todovic et al., 2015), tourism (Hassan and Halim, 2012), plant nutrient management (Hassan and Sahrin, 2012), healthcare planning (Ataollahi et al., 2013) and many more. In the field of financial management, goal programming have been used in portfolio selection (Hassan et al., 2012), assets and liability management (Kosmidou and Zopounidis, 2002), financial planning (Moradi and Janatifar, 2014), funding allocation (Hassan and Loon, 2012) and bank balance sheet management (Thomas and Daniel, 1993).

Giokas and Vassiloglou (1991), Seshadri et al. (1999), Agarana, Bishop and Odetunmibi (2014), as well as Mehri and Jamshidinavid (2015) approached a goal programming technique in banking and financial institutions areas. The data from the financial statements were used in constructing their bank models. Besides that, Kosmidou and Zopounidis (2002) presented a goal programming model of asset liability management for Greek commercial banks. Their considered goals were maximization of returns, reduced risk, the maintenance of liquidity and solvency at a desirable level, as well as the expansion of deposits and loans.

The goal programming model can be extended and integrated with other methods. Tunjo and Zoran (2012) used Taylor's formula to formulate the linearization of fractional functions before applying it in goal programming technique to find the optimal solution for the company's financial structure. Meanwhile, Moradi and Janatifar (2014)

assigned weights for four financial strategies by using linear goal programming and then ranked the strategies by using VIKOR method. Soheyla, Mehrzad and Hadi (2013) developed a mathematical model to find optimum management of assets, liabilities and equity for Mellat Bank. They first determined the priorities of goals using analytical hierarchy process (AHP) before optimizing it using goal programming. The optimal model for liquidity management in Parsian Bank has been proposed by Mohammadi and Sherafati (2015) by using a fuzzy analytic hierarchy process (FAHP) and goal programming.

This study focuses on combination methods of weighted goal programming and pre-emptive goal programming. These methods are mostly used as a goal programming variant because they can be used to determine the weight for a great amount of information goals and ordering them according to preference (Romero and Rehman, 2003). Thus, both weighted goal programming and pre-emptive goal programming methods can be combined (Diaz-Balteiro and Romero, 2003). Even Ekezie and Onuohac (2013) also formulated the goal programming algorithm using the weight method and pre-emptive method for budget allocation of higher learning institutions. Meanwhile, in the application of bank financial statement management, Arewa et al. (2013) 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. Methodology

This paper suggested the combination weights method and pre-emptive method to construct the model. These two methods or algorithms convert multiple goals into a single objective function. This technique is known as a goal programming technique (Taha, 2003). 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:

$$\text{Minimize } Z = \sum_{i}^{n}\left[\left(w_i^+ + w_i^-\right)d_i\right] \tag{1}$$

subject to

$$\sum_{j=1}^{m}\left(a_{ij}x_j + d_i^+ - d_i^-\right) = g_i \tag{2}$$

$$x_j, d_i^+, d_i^- \geq 0 \tag{3}$$

where x_j is the decision variable for $j = 1,2,...m$, a_{ij} represents the parameter of the decision variable, w_i^+ and w_i^- are weights for $i = 1,2,...n$, the deviational variables representing by d_i^+ while d_i^-, and g_i are the aspiration level.

The pre-emptive method is also known as lexicographic goal programming. The decision maker allows ranking the goals in order of importance in this method. Hence, the model is optimized using one goal at a time, according to their priority. The model is written as:

$$\text{Minimize } Z = \sum_{i=1}^{n}\left[p_i\left(d_i^+ + d_i^-\right)\right] \tag{4}$$

subject to equations (2) and (3) above. The pre-emptive factor/priority level is assigned to each goal in order of preference represented by p_i.

The weighted lexicographic goal programming model is a combination of weighted goal programming and pre-emptive goal programming methods proven by Kwak et al. in 1991 (cited in Ekezie and Onuohac, 2013) and the model is given as:

$$\text{Minimize } Z = \sum_{i=1}^{n} p_i \sum_{i=1}^{n}\left(w_i^+ d_i^+ + w_i^- d_i^-\right) \tag{5}$$

subject to equations (2) and (3) above.

3.1. 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 bankscope. 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	
Asset	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	32,470.265	43,814.80	47,742.599	54,741.175	207,433.779
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	7,113,485.079

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	
Asset	0.3367	0.4516	0.4948	0.5603	0.6403	2.4837
Liability	0.3080	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	0.9680	1.2790	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 constraints;

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

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

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

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

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($2d_6^-$):Maximize the proportion of the values of the items in the financial statement.

4. Result and Discussion

In this paper, LINGO Software version 11 is used to obtain the optimal solutions. The findings of goal achievement are illustrated in Table 3 below.

Table 3. Goals achievement

Goals Priority	Output Value	Goals Achievement
P1	0	Fully Achieved
P2	0	Fully Achieved
P3	0	Fully Achieved
P4	0	Fully Achieved
P5	0	Fully Achieved
P6	0	Fully Achieved

Table 3 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 4. Result of deviational variables

Goals Priority	Negative Deviation Variables (d_i^-)	Positive Deviation Variables (d_i^+)
P1	0	0
P2	0	0
P3	0	0.2209441×10^{-2}
P4	0	0.1756789×10^{-2}
P5	0	0.1630925×10^{-1}
P6	0	0.2027548×10^{-1}

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. Likewise, the goal of liability reduction (P2) is also fully achieved since the both values of d_2^+ and d_2^- are zero, which indicates that the total liabilities for 5 years do not change, 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 0.2209441 $\times 10^{-2}$. This shows that the equity wealth goal (P3) achieved and the total equity of the bank can be increased by RM0.0022 trillion per year. Besides, the goal of maximizing the earning (P4) is also achieved since the value of d_4^- is zero and the value of d_4^+ is 0.1756789×10^{-2}. This indicates that the earning 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 0.1630925×10^{-1}, so it can be concluded that maximizing profitability goal (P5) is achieved and the profit 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, P6 is also achieved because the value of d_6^- is zero and the value of d_6^+ is 0.2027548×10^{-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.

5. Conclusion and Recommendations

Based on the finding of the model purposed, all the six goals that have been examined are achieved. This shows that the financial performance of Maybank is good. However, there are four goals, namely equity wealth, earning, profitability and the proportion of the values of the items in the financial statement that can be amended to increase the aspiration level. The proposed model can serve as a guideline for a bank in making decisions and developing a strategy to deal with various economic scenarios. Furthermore, the proposed model can be a tool or solution system that helps banks or other financial institutions to create a plan blueprint and identify their ideal aspiration level or benchmark that can be achieved in the future.

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