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AN ISLAMIC BANK MULTI-OBJECTIVE BALANCE SHEET MANAGEMENT MODEL

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Abstract: *Multi-objectives penalty function optimization models allow one to manage a bank's asset and liability of the real system in a simulated environment to enhance the performance of the system. Looking at its application in promoting the effectiveness of the Assets and Liability Management (ALM) for Islamic banks in Malaysia, the study develops a programming model using optimization approach to the multiple objectives by adding penalty cost functions to cover five main objectives in ALM. The output is a set of solution that minimizes the gap between the targets and actual performance for Bank Islam Malaysia Berhad, taken as the model's validation. The inclusion of the wealth optimization objective for 'equity-like' capital contributors (profit-sharing depositors) is an area which sets the paper different from the traditional shareholders model. Experiments were simulated in the MATLAB environment. The model features the Islamic bank's unique operating scenarios. Inputs consist of the bank's financial information from 2009 to 2013 (for the x vectors consisting of the deterministic data) and k vectors of stochastic data set (gathered by analysing the Islamic banking acts and regulatory requirements). The final output is BIMB's most efficient balance sheet, assets and liabilities composition. The paper has maintained computational tractability while incorporating the model's multiple objectives, which was a difficult tasks when the computing environment was not as advanced. The findings has been able to guide managerial planning and policy making and it steers future research into similar areas.*

Keywords: *balance sheet management, multi-objective, Islamic bank, Investment account holders*

1. INTRODUCTION

The asset and liability management is the core function of the treasury department. The role played by this function is analogous to the role of the human's heart as the

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core of the human's survival. It ensures that funds are managed and channelled to different components within a company efficiently and as effective as possible. Failing this, the company will suffer insolvency and unproductive problems. One of the most important activities by the Treasury department is the balance sheet management. A balance sheet management involves managing a company's resources and liabilities owed from holding the capital needed for its operations, returns from investing these resources (Choudhry, 2007, 2011), risks exposed when carrying these assets and liabilities, and to ensure that these activities adhere to the regulatory and legislative requirements. In financial institutions, the balance sheet management is more complicated. Complications arise due to the different business model, product structures and services offered. Along with these problems the financial institutions' like banks (especially Islamic banks) are exposed to different kinds of risks, such as market risk, interest rate risk, liquidity risk, capital adequacy risk, withdrawal risk, operational risk (*Shari'ah* and reputation risks for the Islamic banks), and so on. Managing these risks would demand for more sophisticated models and computing complexities. Past models of the balance sheet management were merely single goal oriented because of impediments in trying to satisfy contrasting directions contained in multiple the objectivity features in an asset liability management (ALM) context. For example, it is difficult to satisfy both the returns maximization and cost minimization objectives together. However, this research will go further into considering the different objectives in an Islamic bank ALM management. Generally, models development and objectives in the literature placed more emphasis on the conventional interest-based bank balance sheet management. Hence, there is a need to work out for a model that caters to the Islamic bank's unique balance sheet risks and return objectives. To fulfil this objective, the remaining part of the paper is arranged in the following manner; Part 2: Theoretical development and the review of recent models; Part 3: The development of the model and methodologies involved; Part 4: The Model's Validation and its application to Bank Islam Malaysia Berhad (BIMB); Part 5: Discussions and Prospects for Future Research.

2. THEORETICAL MODELS AND LITERATURE STUDIES

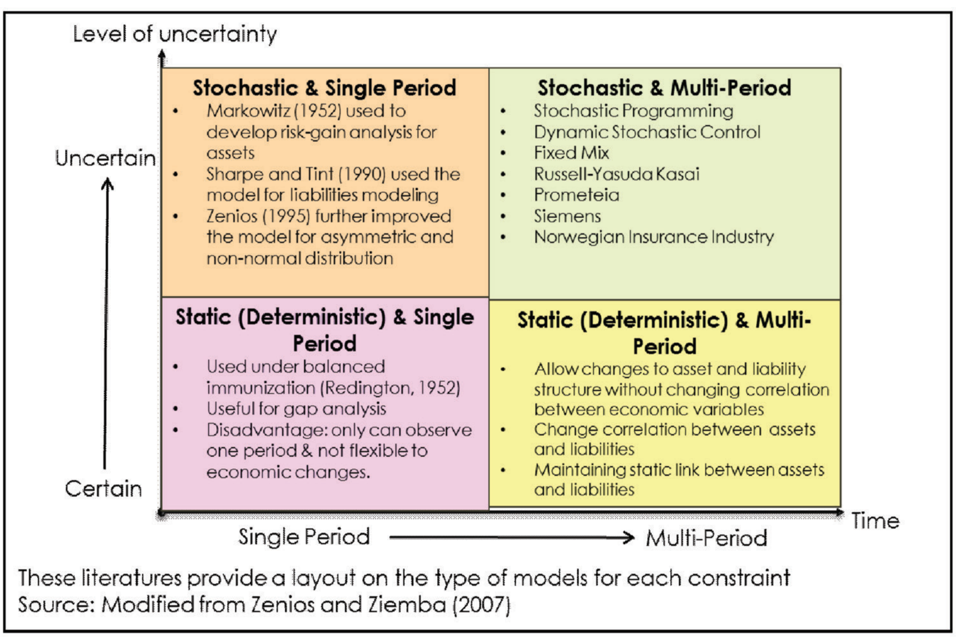
Numerous researchers suggested possible ways to building financial optimization models (Cornuejols and Tutuncu, 2007; Kusy and Ziemba, 1986; Whittle, 1971; Zenios, 1993). Dahl, Meeraus and Zenios (1993) wrote that the modern days' mathematical programming techniques can effectively identify solutions to complex portfolio planning problems with many constraints, thus enabling more precise real world modeling. Although so, quite often difficulties in modeling is provoked by problem based scenarios (Carino *et al*., 1994; Consigli and Dempster, 1998; Kouwenberg, 2001) under asset liability management that has conflicting goals (i.e. maximize returns and minimize risks). The multi-objective penalty optimization can tackle this problem effectively by assigning each goal's relative importance and formulating a new function to solve the problem through recourse strategy. The general model of a two-stage penalty optimization (Herskovits, 1986; Mulvey, Vanderbei and Zenios, 1995) with recourse (Kusy and Ziemba, 1986) for example is able to help identify the set of asset mix that will optimize the asset liability management conflicting objectives (second stage), while minimizing deviations between strategic goals and actual performance (first stage) for *Shari'ah* compliant investments. The following part of the literature analysis gives a brief coverage on the differences between a single and multiple objective optimization problem.

Single Objective Vs Multiple Objectives

Researchers of this kind usually assumes only a maximization or minimization problem at a time. For example, profit maximization or cost minimization, but not both as they are directed in opposite ways or objectives. Apart from this, the researcher needs to identify the set of decision variables, which are factors causing variations in the objective function of an optimization problem. The survey on the multiple criteria (objectives to be met) in the area of finance was performed by Steur and Na back in 2003. There were 265 papers starting 1955 to 2001 synthesized. An update of these methodologies were done by Zopounidis, Galariotis, Doumpos and Andriosopoulos (2015) on multiple objectives optimization models. The actual settings of the nonlinear-programming environment give rise to multiple objectives (Deb, 2014). However, due to its computational complexity and tractability issues, many researchers have provided alternatives to decompose such functions to enable tractable solutions.

One difference between the single and multiple-objective optimization is that the multi-objectivity constitutes a multi-dimensional space (Deb, 2012, 2014; Yu and Gen, 2010) which is different from the vector space of the decision variables. Although, the single and multi-objective optimization is fundamentally different, the users need only one solution (Deb, 2012). This enables the multi-objective optimization problem to be formulated as a composite function of all objectives given their weights to be maximized. Other than this approach, Deb (2012) suggested breaking down of these objectives and solving them one at a time. One of the papers in the literature, which reflects similar optimization problem, conducted by Rezaei *et al.* (2013), tackled the multi-objectivity scenario using fuzzy analytical hierarchy process (AHP) with each objective being allocated their relevant importance obtained though rakings assigned by the bank's management. The ranking was based on comparative judgment to one objective with others applicable to the ALM process. This paper generalizes the "weights" from Rezaei *et al.* (2013) for the ALM actual and target performance deviation minimization. With the example of this study (Rezaei *et al.*, 2013), a decision variable which is, "income generated from the use of the *Mudharabah* depositors" funds is added to the set of maximization objectives. This inclusion is one of the essence of the current research. Most objectives within the area of profit maximization focusses on the bank's ultimate book return that accounts for profit after *zakah* and tax. The decision variables can be in the form of integers or a set of discrete numbers. These numbers are collected over a certain range of intervals which is called the probability density function (Gujarati and Porter, 2010). It can also consist of continuous set of numbers characterized by the cumulative distribution function. Here, the research data is collected by sampling the deterministic and stochastic data from BIMB's annual reports, trend analysis, the expansionary plans and policies from the management's statements and reports from independent rating agencies like the Rating Agency in Malaysia (RAM Holdings reports, 2012, 2013 and 2014). In the theory of optimization, there are other conceptual paradigms considered by a researcher in the process of the right model selection. Besides

Figure 1: Data characteristics quadrant along with the researchers who initiated these models.



Source: Adopted from Zenios and Ziemba (2007) and modified for the illustrative purpose of this research.

the single and multiple objective framework, the choice of model should be based on the characteristics of the problem studied, the type of decision variables examined and it also depends on the need and experience of the policy makers for their tactical or strategic ALM objectives. Zenios and Ziemba (2007) provided a comprehensive summary of the different domains within the optimization field. Other interesting readings can be obtained from optimization methodologies and surveys documented by Dahl, Meeraus, and Zenios (1993) and Zenios and Ziemba (2007). Their writings gave specific insights to the application of optimization models within the area finance.

3. METHODOLOGIES AND THE ALM MODEL DEVELOPMENT

Parts of the model's building blocks are to rectify the essential components (Kruger, 2011) to the multi-objective optimization model. The goal priority weights of this paper is substituted using the essential weights criteria obtained in the research done by Rezaei *et al.* (2013) through Analytical Hierarchy Process (AHP).[1] The basic elements to an optimization model, whether it is single or the multiple objectives) are usually consisting the following; (1) Decision Variables; (2) Objective Function; (3) Constraints; and the (4) Data. Data consists of information from the independent credit rating agency like Ratings Agency Malaysia (RAM) Holdings' reports for year 2012, 2013 and 2014; Bank Islam's financial reports from year 2009 to 2013 to identify the ALM patterns and strategies taken by the bank in ALM related tasks; Islamic Interbank Money Market (IIMM) Yields form the IIMM to get average historical yields; statues and legislative requirements by the central bank of Malaysia. These sets of deterministic nad stochastic data (changes in the top management's policies to adapt to the current economic situation like projected total assets' growth, proportion of funds revenue for charity purposes and so on). Detailed explanation pertaining to the types of data and the formulation of the relevant functions to portray the bank's ALM activities are available in the latter parts of this section.

Preliminary Mathematical Formulation

Space and Matrices

The space matrices represent the decision variables allocations in their deterministic form. After identifying all significant decision variables, these set of input data (in their deterministic form) are fed into the model to generate another set of output

1. The Analytic hierarchy process (AHP) was pioneered by Saaty (1980). It is an approach used to determine the parameters for goal ranking which will be used later, in a multi-objective optimization process.

matrices. These output matrices (also in their deterministic form) are the suggested allocation (in values consistent with the input matrices).[2] These outputs are used to calculate the allocation (or composition) weights for a given portfolio. A simple approach using this technique is the common size analysis which uses total assets as the base for the weights calculation, while the total equities and liabilities is used as the base for items on the right hand side of the bank's balance sheet (liabilities and the equities) weights calculation.

$X = \{1,\ldots,n\}$ = *the line numbers of assets x in deterministic form*

$Y = \{1,\ldots,m\}$ = *the line number of liabilities and equities in deterministic form*

The Problem Data

$P = \{1,\ldots,j\}$ = *priority weights for ALM goals*

$\pm d_i^{\pm} = \{1,\ldots,5\}$ = *goals deviation, over achievement and under achievement*

Current Balance Sheet Data

$X_n = \{1,\ldots,n\}$ = *assets x in deterministic form*

$Y_m = \{1,\ldots,m\}$ = *liabilities and equities in y in deterministic form*

Constraints (the hard and soft constraints)

In the banking environment, the ALM constraint functions can include generalizations made on all of the bank's significant resource limiting factors like the Capital Adequacy requirement by Basel III, the central bank's statutory reserve requirement, the management's plans for assets growth on a yearly basis, liquidity requirements, the bank's annual charity policies and so on.

The Model's Assumptions

The assumptions to the model's application follows Kruger (2011). Assumptions in modelling is the most important stage in mathematical formulation (Chamberlin, 2008). These set of assumptions are based on methodical control over certain decision variables or factors and to abandon insignificant particularities in the problem concerned (Chamberlin, 2008). Although so, we should be cautious to retain qualities that are essential to the optimization problem to maintain the assumptions practicality and reasonableness. The assumptions are verified through literature analysis for multi-objective optimization (i.e. Kruger, 2011),

2. For example, if the input data consists of value in thousands of Ringgit Malaysia, then the output should reflect the same unit of mathematical expression. Should the values consists of ratios, these values will also be reflected in the outputs generated by the system.

queries made to industry's experts like Puan Norashikin and Ustaz Nazri from the bank with which the model is tested.

First assumption for the model's feasibility is that Bank Islam acts as an economic entity which main objective is profit maximization. Putting this clearly, we assume that the bank will act based on its good faith to carry out any duty, with good intention to bring wealth maximization to its owners. As such, the bank will work upon and/or run any activity that is consistent with its shareholder's wealth maximization, including the optimization of assets and liabilities management. Although the research is built on the foundation of multiple objectivity, it is aimed at maximizing the returns of investments, which ultimately contributes to the wealth of the shareholders. The current research advances the model by including the maximization of all 'equity' capital contributors (those including Investment Account Holders) as part of the wealth maximization objectives. The wealth maximization function for the Investment Account holders(the *Mudharabah* depositors) were included after the feedback obtained from Ustaz Nazri, the Director of the *Shari'ah* Division, whereby, all capital contributors should be treated with equitable just and fairness. Knowing that the risks exposure by the different types of investments deviates accordingly, the research encapsulates these differences while formulating the capital requirement function through different risk weights placed on different types of assets. Although this is the case, the second assumption is applicable to investment types that fall under the broader categories according to their assumed homogeneous maturity level like the 'Financing, advances and Others' and the individual assets that are grouped within the different types of investment portfolios (i.e. held for trading, available for sale and held to maturity assets). This applies that the bank employs a standardized method in assessing and managing all investment assets. They are *Murabahah* (mark-up sale), *Ijarah* (lease), *Mudharabah* (a type of profit-sharing partnership between the investor and the entrepreneur), *Musharakah* (joint venture) and so on (Ahmad and Haron, 2002; Haron and Wan Azmi, 2009). Other than these, the third assumption made in Kruger's work was the needed to ensure the model's feasibility. Here, the study referred to Belouafi's (1993) generalization on the different types of investment accounts. The thesis considers only two types of investments classified as (1) *Mudharabah* and (2) non-*Mudharabah* deposit accounts. The methodology used to distinguish the types of investments by the two kinds of *Mudharabah* depositors (i.e. Specific Investment Account Holders and General Investment account holders) is performed to amalgamate capitals from these two types of deposits under one general account that is the General Investment Account. This is because there is no clear distinction in the way both types of funds are mobilized (BNM, 2011). In short, only the General Investment Account Holders are considered as the 'equity-like' capital providers in this research. However, in future researches, this should be noted in the attempt to evaluate wealth maximization objectives for the two types of equity fund providers. Mentioned earlier in Section 2, to maintain the ALM plans of the Bank Islam ALM policy makers and managers, this research focusses on a single period planning horizon. Besides, the breakdown of cash flows occurring within the one year horizon is challenging. These information is not made available to the public and thus, the single period assumption should be placed. Humphrey (1992) agreed in his research that the design of a particular model should be based on data availability. The single period assumption is also supported by the Islamic principle that is not in favour of the increase in the value of money over time due to interest. The principle disallows earnings of interest by the creditors in return for money lent or due to the loss in liquidity and current consumption for money held in the form of receivables or investments (Iqbal, Mirakhor, and Krichene, 2012). In practice, however, when forgone opportunities of industries with similar projects or investments were considered, expected cash flows are discounted with the rates which incorporates a representative risk metric (asset beta) to reflect the estimated net cash (after risks considerations). The fifth assumption to the model is that the funds are segmented based on two maturities; short term and long term horizons. Investments classified under the short term horizon are those available in the Interbank Islamic Money Market Securities held less than one year maturity. Contrariwise, long term securities are held more than one year. Examples of the *Shari'ah* complying capital market investments are stocks issued by *Shari'ah* complying firms and long term Islamic bond (*sak* or *Sukuk*; plural, for those with more than 12 months maturity). Although concerns for liquidity and how this concept is viewed differently across industries (i.e. less than one month maturity is viewed crucially by banking and finance institutions, considering that they are part of the funds centralism or cash management business in nature rather than constructions or property investment driven). To avoid complications in modelling, we assume that this serves as part of the clear distinction between investment horizons, short and long, both based on the research term by definition, using 12 months as the separating operational descriptions. All returns should be considered net *zakah* and tax. This is one of the most crucial sixth assumptions (contrary to the suggestions by Belouafi (1993) in his PhD dissertation). The reasons were *zakah* is seen as a mean to contribute to societal development from a profit making centre like the bank, ploughing returns earned from the society, through contributions back to the people they serve. A research by Abdullah and Suhaib (2011) documented that za*k*ah is not only seen as a mandatory deductions before profit distributions (in terms of dividends) back to the shareholders, it is also seen as a crucial foundation of stability among the *Muslims* society. The seventh assumptions applicable for the model's feasibility is, fixed assets are constant over the periods concerned. For example, during year

2012, the non-current (or fixed assets) are assumed to be constant (although not really the case practically). This is imposed to avoid complication in modelling the constraints in subsequent sections of the paper. Additionally, the paid-up-capital is assumed to stay constant over the planning horizon, suiting the above modelling intentions, as the seventh assumption. Besides, the eighth assumption holds that returns are taken as mean returns rather than absolute returns. These absolute returns are also assumed to be static for the stated periods of intrest (Belouafi, 1993; Chen, Ju and Miao, 2014). The ninth assumption notes that there is no costs to financial transactions. These includes borrowing, lending and investment activities (Bichuch and Sircar, 2014). Bichuch and Sircar (2014) stated in their work that when the returns volatility is assumed constant, historical transaction costs taken to generate costs forecasts using asymptotic approximation will be small. Therefore, within the no transaction costs stochastic environment an optimized investment problem can be analysed with the use of Merton problem. Here, we can take the return-before transaction costs to for the model. Lastly, the model assumes the non-existent of imperfect market. When this assumption takes place, there will be no frictional costs and therefore, prices of securities adjustments are based purely on the perfectly competitive market. This notion hold that no excessive capital is needed in order to maximize the value of a portfolio and also that the frictional costs arising from trading and stockbroking, opportunity costs, research time is minimal (Caballero, 1999).

The Multi-Objective ALM model for Bank Islam Malaysia Berhad (BIMB)

Determine: X_n, Y_m , $\quad with \begin{array}{l} X_n = x_1, \dots, x_{13} \\ Y_m = |y_1, \dots, y_{13}| \end{array}$

Objective Function:

$$\underset{d}{Min}\ g(-d_i^+, +d_i^-) = \sum_{j=1}^{5}\sum_{i=1}^{5} P_j(-d_i^+, +d_i^-) \tag{1.1}$$

$s.t.$

$$h_k(X,Y) = \begin{bmatrix} h_1(X_n, Y_m) \\ \vdots \\ h_5(X_n, Y_m) \end{bmatrix} = 0, \qquad l_c(X,Y) = \begin{bmatrix} l_1(X_n, Y_m) \\ \vdots \\ l_{13}(X_n, Y_m) \end{bmatrix} \leq 0$$

$with\ k = 1, \dots, 5\ and\ c = 1, \dots, 13$

The objective function above minimizes deviations between the actual and expected performance and with real data (for actual performance) and model simulated data (used to obtain the expected ALM performance) for Bank Islam. The objective function above in equation 1.1 is constrained by both binding and non-binding constraints. The factors for these constraints are the bank's balance sheet items. Detailed mathematical denotions for the variables above can be obtained from Appendix A in **Table 1.6** of the paper.

The details of the constraint functions, h_k (X,Y), (X,Y) are as follows:

$$\left[0.0274x_1 + 0.0633(\sum_{i=4}^{7} x_i + x_2 + x_{10}) + 0.075x_3 + 0.0346x_8 + 0.04x_9\right] - [0.05y_1 + 0.0495y_2 + 0.0367y_3 + 0.0735y_4 + 0.0325y_5 + 0.0325y_6] + d_1^- - d_1^+ = 1.9144 \times 249910 \quad (1.2)$$

This function represents the operational income from absolute investment portfolios, loans and advances, and services provided net absolute costs from customer deposits, bill, acceptances and other forms of liabilities.

$$\sum_{j=10}^{13} y_j - 0.08\left[0 \times (x_1 + x_8 + x_{12}) + 0.2\left(\sum_{i=2}^{7} x_i + x_9\right) + 0.125(x_{10} + x_{11}) + x_{13}\right] + d_1^- - d_1^+ = 0 \quad (1.3)$$

Formulation of this function follows the capital requirement set out in Basel II.

$$x_1 - 0.01\sum_{j=1}^{5} y_j + d_2^- - d_2^+ = 0 \quad (1.4)$$

This is the liquidity requirement by the central bank. To satisfy withdrawal claims by the now account holders.

$$\sum_{i=1}^{13} x_i + d_3^- - d_3^+ = 1.15 \times 37{,}422.8mil \quad (1.5)$$

This represents the total projected asset growth by the top management policies. Information relating to this can be obtained from the bank's 2012 annual report on the chairman's statement that the bank plans to epand by 15% on the following year in terms of total assets' growth.

$$\sum_{i=2}^{10} x_i - 0.85\sum_{j=1}^{6} y_j + d_4^- - d_4^+ = 0 \quad (1.6)$$

This function represents total deposit facility provision where the bank intends to increase its deposit products which will eventually improve its total capital from the depositors. This growth will facilitate investments on assets x_2 to $x_{10.}$ The type of deposits concerned are both the *Mudharabah* and non-*Mudharabah* types of deposits.

$$y_3 \leq 1.1358 \times 12972473.12 \tag{1.7}$$

This represents the ideal but not binding requirement on returns available to the *Mudharabah* depositors. The projection was done based on analysis performed on the historical annual returns made available to this group of investor.

$$\sum_{j=1}^{6} y_j + \sum_{j=10}^{13} y_j - \sum_{i=1}^{10} x_i = 0 \tag{1.8}$$

This function necessitates that the sources and uses of funds uses be equal. This function also ensures that the balance sheet equation is achieved.

$$0.03 \sum_{j=1}^{6} y_j \leq x_1 \leq 0.05 \sum_{j=1}^{6} y_j \tag{1.9}$$

This function is derived from the possible withdrawal risk faced by the Islamic bank. This is a unique risk in addition to general risk types faced by interest-bearing banks.

$$x_{12} \leq 0.03 \sum_{j=1}^{6} y_j \tag{1.10}$$

This function holds the minimum amount of fund required to be held by banks as statutory reserve requirement.

$$\sum_{i=1}^{13} x_i - \sum_{j=13}^{13} y_j = 0 \tag{1.11}$$

Similar to equation 1.9, this function does not exclude the amount of funds regulated by relevant authorities within the banking environment. This function merely portrays the accounting equality that necessitates the amount of the debit side of the balance sheet to equal the amount held on the credit side of the balance sheet.

$$0.2 \times \sum_{j=1}^{6} y_j - x_1 \geq 0 \tag{1.12}$$

The structural cash requirement function represents the liquidity coverage ratio that the bank is will maintain as part of its ALM policy. This function is deduced from the analysis of the bank's past liquidity coverage ratio. $x_1 \leq 0.03(y3)$

$$x_2 + \sum_{i=8}^{10} x_i \geq 17781.6124 \tag{1.13}$$

As part of the profit sharing with *Mudharabah* capital providers, these pre-agreed ratio to profits or losses represents only ideal sharing portion maintained by the bank, on average portion.

$$x_2 + \sum_{i=8}^{10} x_i \geq 17781.6124 \tag{1.14}$$

This is the ideal portion of the total funds available for investments in *Mudharabah* types of investments so that the bank participates as the capital contributor to promote the entrepreneurial economic activity in Malaysia. This function is obtained from the analysis of the bank's annual reports and the bank's main webpages.

$$0.3 \sum_{i=2}^{7} x_i + \geq 597380 \tag{1.15}$$

The bank held that 30% of its customers' credit card revenues during the month of *Ramadhan* to the charity program, '*Amal Jariah*'. The right hand side of the equation has been prorated to reflect only transactions occurring in the month of *Ramadhan*.

$$0.014 \sum_{i=2}^{7} x_i \leq 19507.8 \tag{1.16}$$

To maintain the bank's credit and funding quality, this ratio holds that not more than 1.4% of the total loans should fall within the bank's projected impaired financings.

$$1.2x_7 + 1.0x_8 + 1.2x_9 + 1.4_{10} \leq 0.5\left[\sum_{j=1}^{6} y_j + \sum_{j=10}^{13} y_j\right] \tag{1.17}$$

This represents not more than 50% of the total funds are allocated to the fixed term loans, personal borrowings, vehicles and assets loans. The purpose of this function is to limit the amount of investment in higher maturity assets that could also lead to higher possibilities for impaired financing.

$$0.7 \leq \left[\sum_{i=2}^{7} x_i \div \sum_{j=1}^{6} y_j\right] \leq 0.8 \tag{1.18}$$

Analysing the bank's ALM policy, we identified that the management's optimum financing to deposit ratio should be between 80% or less (RAM, 2012). (1.19)

$$P_j, d_i^-, |d_i^+|, X_n, Y_m \geq 0 \tag{1.19}$$

These are non-negativity constraints to prohibit short selling. According to the principles in Islam, Muslims are prohibited from shorting a transaction (Wajdi Dusuki, 2008). (1.20)

The following part of the papers shows the application of the ALM model using the model's simulated data for Bank Islam.

4. VALIDATION AND APPLICATION TO BANK ISLAM MALAYSIA BERHAD

This section is concerned with the results of an application of the ALM model to the asset and liability portfolio problem of Bank Islam Malaysia Berhad (BIMB). In addition to these results, some of the technical aspects for the model's implementation are accompanied by description pertaining to the model's formulation, below. In all aspects covering assumptions related to the model has been designed with care so that it reflects the real life problem continuously faced by this institution (especially with Islamic fund management problems). In concluding the algebraic representations and development stage, further information regarding the bank's regulating and legislative environment were gathered. They are decrees and statutes governing the operations of the Malaysian Islamic banks and financial institutions. The output of this model is the set of proposed assets and liabilities. Refer to Appendix B, Table 1.3 for the simulated assets and liabilities allocation for Bank Islam in year 2012 nad 2013. A comprehensive test and analysis were performed to understand the simulated outcome suggested by the ALM model. Table 1.0 consists of the results (over- or under- achievement, denoted by the two signs elaborated in the following paragraphs. These are the expected results should the follow the simulated assets and liabilities composition suggested by the model. Results are summarized according to the target descriptions (ALM objectives ranked according to the perceived level of importance by the management). Table 1.0 carries summaries on the different return categories contained in this section; the bank's overall operating profit, returns from holding investment assets recommended by the ALM optimization system, and profit obtained from giving finances to customers. Discussions about the suggested outcomes on Table 1.0 thru Table 1.5 are covered in the following subsections. The final part of the paper (Section 5) provides discussions and other potential research areas. The originality of this paper is within the comparisons of the simulated and real outcomes for years 2012 and 2013, should the bank implements the proposed allocation or with the guide of its actual financial position.

Table 1
BIMB's current Balance sheet performance with 2012 and 2013 input data

Results of The Deviations for Target Constraints 2012 and 2013							
Target Descriptions	*Variable*	*2012 Values (RM in Mil)*	d_i^+ $i = 1,\dots,5$	d_i^- $i = 1,\dots,5$	*2013 Values (RM in Mil)*	d_i^+ $i = 1,\dots,5$	d_i^- $i = 1,\dots,5$
Performance Revenue	P1	N/A	N/A	N/A	297,570.55	1	0
Capital Adequacy	P2	2,204,379.75	1	0	2,717,379.11	1	0
Liquidity	P3	1,370,398.1	1	0	3,362,046.10	1	0
Total Assets Growth	P4	N/A	N/A	N/A	46,181,764.78	0	1
Total Deposit Facility	P5	13,656,025.20	1	0	5,285,671.15	1	0

Note: d_i^+, d_i^- denotes over- and under-achievement using the bank's actual balance sheet figures. When the value 1 is applied to d_i^+ in P1, it shows that for target P1, the bank experience over-achievement. Whereas, if the value 0 is applied to, d_i^- the bank under-performed for target P1. Results for performance revenue (P1) and total assets growth (P4) are not applicable since plans for revenue and assets growth expected for year 2012 takes some time to be realised and that its effect could be observed in 2013.

Table 2
Targets achievement using proposed assets and liabilities allocation for 2012 and 2013

Results of The Deviations for Target Constraints 2012 and 2013							
Target Descriptions	*Variable*	*2012 Values (RM in Mil)*	d_i^+ $i = 1,\ldots,5$	d_i^- $i = 1,\ldots,5$	*2013 Values (RM in Mil)*	d_i^+ $i = 1,\ldots,5$	d_i^- $i = 1,\ldots,5$
Performance Revenue	P1	N/A	N/A	N/A	486,760.48	1	0
Capital Adequacy	P2	10,699,290.00	1	0	7,588,928.69	1	0
Liquidity	P3	520,080.41	1	0	224,129.79	1	0
Total Assets Growth	P4	N/A	N/A	N/A	224,536.35	0	1
Total Deposit Facility	P5	17,637,321.14	0	1	5,849,821.39	0	1

Note: Projections for 2013 'Performance Revenue' and 'Total Assets Growth' are done using proposed assets and liabilities composition for year 2012. Therefore, results for these two targets are not applicable to year 2012.

Table 3
Deviations in targets achievement: Comparison between actual and expected performance for 2012 and 2013

Target Descriptions	*Variable*	*2012 Values (RM in Mil)*			*2013 Values (RM in Mil)*		
		Expected performance	*Actual performance*	*Difference*	*Expected performance*	*Actual performance*	*Difference*
Performance Revenue	P1	N/A	N/A	N/A	806,403.19	292,040.05	514,363.13
Capital Adequacy	P2	793,234.52	788,715.55	4,518.52	1,941,865.04	251,629.42	1,690,235.62
Liquidity	P3	1,133,748.21	1,127,851.18	5,897.03	361,976.48	1,371,915.12	1,009,938.64
Total Assets Growth	P4	N/A	N/A	N/A	5,804,561.00	10,401,712.00	4,597,151.00
Total Deposit Facility	P5	93,161,809.70	27,719,428.94	65,442,380.76	10,981,041.93	63,234,976.25	52,253,934.32

Note: Table 1.2 consists of results showing BIMB's expected and actual performances for targets P1 to P5 described above. These performances are obtained through calculations using constraint formulas developed in Section 3 of the paper. They are replicated below for the readers' convenience. Input for the formulas were done with simulated data (to get results for expected performances) and actual balance sheet data (for BIMB's current performances).

Target Deviations from Expected Goals and Performance

Further discussions to results obtained in Table 1.1 using simulated proportions of assets and liabilities by the asset and liability model within the MATLAB R2009b environment are available throughout this sub-sections. Table 1.0 and 1.1 consist of results that are arranged in the following format; (1) deviation values for years 2012 and 2013 (these deviations represents gaps between the expected and actual performances using BIMB's simulated and actual balance sheets for the asset and liability model and these values are given in millions of Ringgit Malaysia); and (2) dummy values of 1 and 0 to denote manifestations of the under- or over-achievements for targets P1 to P5. For example, dummy variable of 1 for for P1, represents over-achievement for target P1 (Performance Revenue). Accompanying explanations to each targets' deviation will be elaborated below.

Forecasted Results, Slacks and Surpluses

Achievements using proposed asset and liability allocation for targets 1 to 5, denoted by P1 to P5 are shown in Table 1.0. The positive or negative outcomes for under- or over- achievement of the asset and liability management targets depends on the severity of such deviation (Kumar and Leonard, 1988). The deviation's impact is assigned using parameters of importance acquired from the fuzzy AHP process, also performed by Rezaei *et al.* (2013). This method prevents over- and under-valuation for targets that are conflicting with other targets assessed.

From Table 1.1, the bank will have an over-achievement for its revenue performance by RM 514,363.13 million above its actual performance (which is also experiencing an over-achievement of RM 292,040.05 million. These figures were obtained by substituting the actual financial and simulated data into equation 1.2 above. For convenience, the replica for equation 1.2 is presented below;

$$\left[0.0274x_1 + 0.0633\left(\sum_{i=4}^{7} x_i + x_2 + x_{10}\right) + 0.075x_3 + 0.0346x_8 + 0.04x_9\right] - [0.05y_1 + 0.0495y_2 + 0.0367y_3 + 0.0735y_4 + 0.0325y_5 + 0.0325y_6] + d_1^- - d_1^+ = 1.9144 \times 249910 \quad (1.2)$$

The performance revenue results is only applicable to year 2013 because projections for year 2013 can only be done with 2012 data. Next, target P2 shows the bank's capital adequacy performance using both simulated and actual financial data into equation 1.3. With the model, the bank has an over-achievement performance for year 2012, more than the over-achieved results obtain with the actual data by RM 4,518.52 million. The results were more favourable in year 2013 if the bank applies the ALM model. It shall have an over-achievement above its current performance greater than year 2012. Processes to obtain these results are similar to processes used to obtain results for target P1, with the two types of data being fed into equation 1.3.

Target P3 represents the bank's achievement for its liquidity management. Working on the current allocation, the bank is experiencing an over-liquid position given an over achievement indicated by the dummy value for d_2^+ in Table 1.0. The over-liquid position can be lowered if the bank follows the suggested assets and liabilities allocation using the model, and the new over-achievement for liquidity provision will drop to RM 361,976.48 for year 2013, those closing the variance between expected and actual performances. Refer Table 1.0. The results were obtained with both types of data being inputted into equation 1.4, above. As we can see from these results, the Islamic financial system faces liquidity problem (RAM, 2014) arising due to the lack of money market instruments available in the Islamic Interbank Money Market (IIMM).

Target P4, total assets growth in Table 1.0 showed an under-achievement. These results are the outcome of data substitution into equation 1.5 with same methods applied to previous targets discussed. Analysing the results, the gap between the actual and simulated performance for year 2013 (Refer to Table 1.1) has fallen, with the simulated results' under-achievement being lesser than the actual over-achievement, thus creating a variance of RM4.6 million. This might possibly signal that the bank is engaging in organic expansionary moves rather than mechanistic expansionary, that is characterized by aggressive acquisition and takeover actions. In this type of slow and conservative growth, total assets will grow in a steady and gradual momentum, characteristics that are different than the aggressive, rapid and mechanistic growth. Similarly, the total assets growth target is performed using planned percentage of growth expected in year 2012. Note that the results are only available to year 2013. Same reason applied to target P1, projections for 2013 total assets growth were done using the ALM top management's forecast in 2012. Lastly, Target P5, the total deposit facility provision represents that bank's aggression in its effort to expand deposit facilities and the range of products to capture a wider market share, whilst competing with the conventional banks. The bank experience over-achievement with its current balance sheet data. However, it could perform better by a variance of RM65 million (See Table 1.1) if it implements the simulated allocation for year 2012 and RM52 million for year 2013. The results can be generated using equation 1.6 above with similar methods discussed earlier. Readers should be aware that the suggested allocations were based on current and simulated data by the model. Further investigations on factors causing the over- and under-achievements of these targets should be performed to understand the current ALM performance of the bank.

Proposed Assets and Liabilities Composition

The proposed and current assets and liabilities compositions can be made meaningful if we perform the common size analysis with the total assets as the base year since results obtained for the assets and liabilities matrices are only two years (i.e. 2012 and 2013). Appendix B, Table 1.3 shows comparisons of the two years' proposed and actual allocations. These were also the figures used to generate the over- or under- achievement gaps discussed earlier. From the common size analysis, we summarize that the proposed allocations and the current allocations deviate in slight significance. The assets allocations suggested for BIMB's assets for year 2013, following the sequence of asset x1 till x13 are summarized as 0.016, 0.1, 0.044, 0.016, 0.666, 0.005, 0.007, 0.02, 0.039, 0.028, 0.017, 0.034, and 0.007. Whereas, proposed allocations for liabilities starting with y1 to y13 can be summarized as 0.601, 0.066, 0.011, 0.051, 0.06, 0.002, 0.011, 0.139,0, 0.019, 0, 0, and 0.041. Assets allocations for year 2012, following the earlier sequence are 0.039, 0.222, 0.141, 0.106, 0.15, 0.009, 0.016, 0.053, 0.067, 0, 0.064, 0.104, and 0.029. Proposed allocations for 2012 liabilities are 0.4, 0.001, 0.007, 0.394, 0.024, 0.014, 0.006, 0.096, 0.007, 0.012, 0, 0.01, and 0.029. We can compare these allocations with the actual allocations analysed using the common size analysis for the two years. Table 8.3 also provides this comparisons with the proposed and actual allocations placed next to one another for a clearer view on the deviations for the two results. As we can see, the deviations are not significant. Taking a closer look into the suggested and actual allocations for asset x1 given for year 2013, the allocation compared to the size of the total proposed value of assets when all objectives are satisfied, the bank should allocate an amount which is 1.6% out of its total assets to cash and other short term near cash liquid assets compared to 8.6%, which is the actual balance sheet composition in year 2013.

The proposed total financing, advances and others were estimated to increase from year 2012 to 2013. Satisfying the multiple objectives of the bank's ALM, the bank should increase its financing, advances and others portfolio from 0.644 to 0.835 (taken by adding all variables x2 to x7). The following section provides a detailed coverage of the compositions of the financing, advances and others alike assets (generally, it means loans non-interest asset-backed loans). Next, we can see the common size ratios calculated for both equities and liabilities to total equity and liability capital. We can see that in satisfying the bank's multiple ALM objectives, the proposed composition for Mudharabah type of saving increased from year 2012 to 2013, that is, 0.408 to 0.678. These values are higher than the current Mudharabah savings compositions (total value of variables value of variables y1, y2 and y3 experienced by the bank (See Table 1.3). The supporting comment on the preference for this type of deposit capital is its lower costs than other forms of deposit capital. Additionally, one may also argue that this type of capital (especially investment like deposits such as the bank's General Investment and Special Investment Accounts are allowed by the AAOIFI (2008) as one of the bank's core capital components to absorb unanticipated or contemporary business risks). The proposed non-Mudharabah deposits composition (results obtained by totalling variables y4 and y5) dropped from ratio 0.408 in year 2012 to 0.111 in year 2013. Whereas in actual, there is only slight drop experience by the bank (shown in Table 1.3) that is, from 0.418 to 0.328. The summation of the total equity (y10 to y13) proposed by the ALM model in Table 1.3 suggested an increased by 17% as compared to its actual decreased of 2.5%, that is calculated using the balance sheet data for both years.

A brief look into the bank's liquidity management, should the bank followed the suggested allocation it will have an improved total current assets ratio from year 2012 to year 2013, from 0.956 times to 1.141 times. Comparing with the actual ratios, the respective ratios were 0.937 and 2.951 times. With the proposed assets allocation, the current ratios do not deviate much from one year to another. Although the actual current ratio suggests that the bank has higher performance for year 2013, RAM (2014) reported that the bank is facing over-liquidity problem.

Table 1.3, Appendix B, compares the actual and proposed values for assets and liabilities in year 2012 and 2013, and the common size analysis with total assets as base comparison. The section that follows details performances of the bank's lending and investment portfolios for year 2012 and 2013 based on its current ALM allocations.

Proposed Weights for Financing, Advances and Others

From Table 1.1 and 1.3, we see that the proposed allocations has increased from 0.644 in year 2012 to 0.838 to year 2013. This justifies the need increased allocation for this group of assets. Backed with the current awareness on the increased returns to these group of assets (BIMB, 2014). Applying the simulated assets allocation, the bank's absolute revenue could be alleviated, which is in favour to its operating margin. On the other hand, operating costs from the deposit side of can be minimized by attracting more capital from deposit products that are *Mudharabah* based. The proposed allocation can be justified by the lower cost of *Mudharabah* capital compared to funds from other liabilities and equities. One can turn to results from the proposed allocation on performance revenue (i.e. target P1 in Table 1.2). In order to make the analysis more meaningful, one may perform the interest rate sensitivity test on the changes in the market rate and its outcome on the bank's net interest margin. The sensitivity analysis allows us to understand the outcome any occurrence, like the change in the market rates, and to look at how this will affect the asset and liability management process. In this regard, the sensitivity testing can also be used to ascertain flaws in a given model (in this case, the asset and liability management model). Should there be any weakness or the model turn out to bear insignificant contribution, the modeller can modify and take necessary remedial actions to improve the model's practicality. Summarizing this, we can say that (based on table 4) higher allocation should be given to financing based on *Murabahah* and least to *Tawarruq*. The generated suggestions should be accompanied by rationales from the higher returns (higher risks) notion in finance. Besides, we can also see that more effort should be given to promote *Murabahah* as a financing and less to *bai bithaman ajil* (Refer to table 4 below).

Table 4
The ratios of the Shari'ah compliant loan types in relation to its total value of Financing, Advances and Others for year 2012 and 2013

Products	*Current portfolio composition for financing, advances and others*			*Proposed portfolio composition for financing, advances and others*	
	Variables	*2013*	*2012*	*2013*	*2012*
Bai bithaman Ajil	X2	0.378	0.319	0.120	0.344
Bai' al-'inah	X3	0.053	0.055	0.053	0.344
Ijarah	X4	0.010	0.009	0.019	0.165
Murabahah	X5	0.035	0.051	0.794	0.233
Tawarruq	X6	0.515	0.283	0.006	0.014
Other modes of financing	X7	0.009	0.283	0.009	0.025
Total		**1.000**	**1.000**	**1.000**	**1.000**

Proposed Investment Assets Allocation

Extracting results from Table 3 in Appendix B, we have the summary for investment assets allocation using the portfolios total capital as the base in Table 5. The budgeted allocation for the held-for-trading (HFT) investment assets (denoted as X8), declined from year 2012. However, this decline does not constitute to a lower amount of fund to be channelled to this source of investment. Compared to the actual allocations, it experienced a decline in budget allocation from year 2012. Next, we can see the decline in the proposal for assets allocation to the available-for-sale (AFS) portfolio in year 2013. This slight decrease has witnessed the funds' lower performance in that year compare to other investments. Although so, the actual allocation shows no significant decline for this year. Lastly, Table

5 suggested that, based on the ALM model, BIMB should increase their budget for the held-to-maturity (HTM) group of investment. It should be noted that the suggested results are performed based on the model's consideration for various factor affecting the performance of the bank's balance sheets for these two years (2012 and 2013). As an alternative to the suggested allocations, the bank's current portfolio performance suggests that there should be a decline to the focus given to this group of investment. The next section of this paper offers discussions which include the model's validation and recommendation for future research in Section 5, as the conclusion of the paper.

Table 5
The proposed and current balance sheet allocations for held-for-trading (HFT), available-for-sale (AFS) and held-to-maturity (HTM) assets for year 2012 and 2013

Items	*Variables*	*Proposed allocation*		*Current allocation*	
		2013	*2012*	*2013*	*2012*
HFT	X8	0.232	0.440	0.089	0.110
AFS	X9	0.447	0.560	0.907	0.878
HTM	X10	0.320	0	0.005	0.012
TOTAL		**1.000**	**1.000**	**1.000**	**1.000**

Results Validation

The model's validation can be done by performing a test using a case, for example, its application (Consiglio and Zenios, 2014; Xidonas and Mavrotas, 2014) into a given context like Bank Islam Malaysia Berhad. Most literatures in the area of multi-objectives bank management demonstrated the validation of the model using real balance sheet numbers. Alternatively, Kumar and Leonard (1988) used advanced the multi-objective model for a hypothetical bank with arbitrary numbers generated to demonstrate how their model works. Another form of validation can be performed using sensitivity analysis with the model's suggested results can be treated as another point of validation (Venkataraman, 2009, p. 77; Sargent, 2005; December). The paper performed three stages of validation for the ALM model. The first validation stage (mentioned in Section 3, as part of the model's formation), interviews on two significant personnel (the directors of the Treasury Division, Pn. Norashikin and Ustaz Nasri Chik, the chairman of the *Shari'ah* Division) to solicit inputs regarding the variables of the ALM model, the problem statement of the ALM optimization for Bank Islam Malaysia Berhad, as part of the model's practicality enhancement stage (Louwerens, 2014). In Louwerens' (2014) study, interviews were performed on the real estate manager to verify the factors considered in the real estate investment trust portfolio management. Apart from the clients' preferences on risks and returns level, other elements like the liquidity, the quality of assets held in a given trust were also taken as the determinant in decision making. Validation within the system were performed using several refutations, reductionism and repetitions until data convergence occurs (Venkataraman, 2009). This can be known also as data-fitting. Interested readers can refer to Venkataraman's reference on applied optimization using MATLAB programming for better understanding on how MATLAB functions can be used to validate the simulated outputs. The MATLAB programming codes of this ALM model can be given upon written request made to the corresponding author of this paper.

5. DISCUSSIONS AND PROSPECTS FOR FUTURE RESEARCH

Emerging methods using MATLAB programming environment for optimization problems are aplenty. This include convex programming tool, the TOMLAB©, the Genetic Algorithm functions and so on, can be considered depending on the user's preferences which include interface, comprehensiveness, available number of options and capabilities and most importantly, the general characteristics of the problem studied. Researchers should however refer to several options before resorting to conventional models. A key to note when selecting the best suiting program is to analyse and understand the problem studied. Technical users ought not to be worried as the programming codes of these conventional tools can be modified according to the customized environment of a particular problem. This is important in order to obtain results with higher precision and are more robust. A model's usability depends also on the assumptions assigned to promote it. There is no need for a set of highly precise assumptions. However, the model implementation must be accompanied by a set of reasonably parsimonious assumption to maintain the applicability of a mathematic model (Chaturvedi, 2010; Venkataraman, 2009).

As for this research, there are several limitations identified during the methodological processes. In the ontological perspective, we know that most of the variables of the ALM model has been simplified for the computing purpose. This approach is important to maintain computational tractability (Zenios and Ziemba, 2007; Chaturvedi, 2010 and Venkataraman, 2009). Nevertheless, it should be noted that future researches should be conducted to reflect the best possible scenarios of the ALM setting. This can be done by performing repeated interviews and working closely with the asset and liabilitiy committee or ALCO. The unresolved challenge faced by this research in obtaining cooperation from the time constrained managers has led to other reasonable and sufficiently valid options for the model's input using static and deterministic single period data from the bank's financial reports. Mentioned in Section 2, this approach was also adopted by a significant number of researches to qualify for an academic model to the ALM practitioners (See Poorman, 2004). This approach has also been taken to substitute the priority weights of relative importance for the different sets of soft, goal constraints in ALM model. In summary, as a precautionary measure, future researches should undertake similar studies with greater concerns placed on data availability.

For better accuracy, potential researches of this area should consider the different timing of cash flows (or resources) so that the effects of resource allocation within differing scenarios can be studied. Like Viswanathan, Ranganatham, and Balasubramanian (2014), and Charnes and Thore (1966), the different timing of the cash flows can be assigned by supplementing the levels of probabilities to these cash flows occurring within the period studied. Additionally, one can perform the more robust approach to the optimization model validation using results generated by neural network. The MATLAB programming software can be used to cater for this purpose. With the results generated by the neural network, one can compare the significance of these deviations. Besides, the MATLAB Community (2013) suggested simulating the model for the model's validation (Attaway, 2013). One can compare the patterns and behaviour of the two types of model's outcome (using suggested and real data) to check for significant discrepancies, if exists, between the two outputs.

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APPENDIX A

Table 6
Mathematical notions for Bank Islam's balance sheet items (in RM '000)

Variable designation	*Asset Category*	*Variable designation*	*Liability Category*
X_1	Cash, and other short term near cash liquid assets	**Demand deposits:** ***Mudharabah funds***	
Financing, advances and others		Y_1	Savings deposits
X_2	Bai bithaman Ajil	Y_2	Specific Investment Account
X_3	Bai' al-'inah	Y_3	General Investment Account
		Demand deposits: Non-Mudharabah funds	
X_4	Ijarah	Y_4	Demand deposit from customers
X_5	Murabahah	Y_5	Negotiable Islamic Debt Certificates, Ziyad and others
Variable Designation	Asset category	Variable Designation	Liability category
		Other types of deposits	
X_6	Tawarruq	Y_6	Deposits and placements from other financial institutions[3]
X_7	Other modes of financing	**Other Liabilities**	
Investment securities portfolio		Y_7	Bills and Acceptances Payable
X_8	Held-for-trading securities	Y_8	Other liabilities, accrued zakah and tax liabilities
X_9	Available-for-sale securities	Y_9	Derivative financial liabilities
X_{10}	Held-for-trading securities	**Equity Category**	
X_{11}	Derivative financial assets	Y_{10}	Paid up capital
X_{12}	Statutory reserve	Y_{11}	Share premium
X_{13}	Non-current assets	Y_{12}	Retained earnings
		Y_{13}	Other reserves

3. These funds are usually saved in the form of Mudharabah agreement between the bank and other financial institutions (Usmani, 1999).

APPENDIX B

Table 7:
Comparisons between the actual and proposed values for assets and liabilities in year 2012 and 2013, and the common size analysis with total assets as base comparison.

Assets						
Variables	*2013*			*2012*		
	Proposed allocations	*In Common size ratio*	*Common size ratio based on 2013 balance sheet*	*Proposed*	*In Common size ratio*	*Common size ratio based on 2013 balance sheet*
X1	703,326.05	0.016	0.086	1,441,535.51	0.039	0.037
X2	4,345,070.43	0.100	0.212	8,267,665.80	0.222	0.189
X3	1,912,066.37	0.044	0.030	5,258,088.51	0.141	0.033
X4	671,135.15	0.016	0.006	3,958,715.40	0.106	0.005
X5	28,829,382.38	0.666	0.019	5,587,735.41	0.150	0.030
X6	225,851.16	0.005	0.288	335,141.32	0.009	0.168
X7	308,639.64	0.007	0.005	597,817.00	0.016	0.167
X8	873,428.09	0.020	0.028	1,966,996.40	0.053	0.035
X9	1,681,264.78	0.039	0.287	2,501,054.86	0.067	0.279
X10	1,204,506.33	0.028	0.001	-	0.000	0.004
X11	734,808.37	0.017	0.001	2,378,098.98	0.064	0.000
X12	1,462,314.97	0.034	0.030	3,870,563.96	0.104	0.023
X13	309,067.28	0.007	0.006	1,068,245.85	0.029	0.030

Liabilities						
Variable	*2013*			*2012*		
	Proposed	*In Common size ratio*	*Common size ratio based on 2013 balance sheet*	*Proposed*	*In Common size ratio*	*Common size ratio based on 2013 balance sheet*
Y1	25,997,665.15	0.601	0.054	14,898,006.51	0.400	0.052
Y2	2,846,040.78	0.066	0.047	44,939.83	0.001	0.058
Y3	477,042.52	0.011	0.440	277,023.17	0.007	0.347
Y4	2,210,102.14	0.051	0.289	14,650,939.28	0.394	0.308
Y5	2,604,105.98	0.060	0.039	907,821.50	0.024	0.108

Y6	65,399.20	0.002	0.036	503,072.70	0.014	0.023
Y7	459,761.45	0.011	0.004	206,652.90	0.006	0.010
Y8	6,007,185.64	0.139	0.012	3,590,131.59	0.096	0.014
Y9	-	0.000	0.000	244,169.63	0.007	0.000
Y10	830,164.92	0.019	0.054	453,790.66	0.012	0.061
Y11	-	0.000	0.001	6,545.05	0.000	0.000
Y12	-	0.000	0.006	376,418.71	0.010	0.006
Y13	1,763,393.21	0.041	0.017	1,072,147.47	0.029	0.013