Modeling Portfolio Based on Linear Programming for Bank Business Development Project Plan

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***Abstract*—The bank's business processes target business plans for the next year. Existing conditions, the business plan is based on the growth asset portfolio every year, so that the purchase of productive assets awaits issuers' offers. This condition will cause a portfolio not to be measured and the inaccuracy of portfolio selection. Asset Liability Management (ALM) is the management of the structure of assets and liabilities to achieve profit. Banking books and trading books are bank portfolios to earn income. In selecting each portfolio, it contains liquidity risk, market risk and, credit risk. The level of profit is reflected in returns, while returns and risks are a trade-off so that calculations require mathematical and simulation models. Each bank needs an overview of the composition of productive assets, as short-term, medium-term and, long-term assets must be measured risk and target achievement. Linear programming method will allocate productive assets as the bank's leading source of income, to achieve optimization of profit on the risks received. The problem with this research is that there are 830 variables as banking assets and 19 constraints as indicators of risk. In the seventh iteration of mathematical models, return 1,803 Trillyun from 11 banking book assets.**

***Index Terms*—productive assets, banking book, constraint.**

I. Introduction

THE current condition of the business plan is considered to be less integrated between the target business units and has not measured the potential risks. Such a business plan has an impact on uncertainty in implementing business plan targets. One component in preparing a business plan is an asset strategy. Asset strategy affects the bank's portfolio, then portfolio allocation becomes the application of the annual business plan. The bank portfolio concerns productive assets, banking book assets and, trading book assets. Both of these elements become a source of income for the bank, and income can be in the form of interest rates and capital gains.

Determining the allocation of banking book assets and trading book assets is very important to obtain optimal profits from the risks received. Based on research [1] Optimal Asset Liability Management with Liquidity Constraints and Stochastic Interest Rate in the Expected Utility Framework, liquidity is a limiting factor for obtaining interest income. Based on research [2] measurements of Computing Near-Optimal Value at Risk Portfolios using Integer Programming Techniques, the measure of risk is calculated by Value at Risk which then uses Integer Programming Techniques.

In this study, a mathematical model will be created that integrates the assessment of market risk and the risk of liquidity in the bank's productive assets. In Indonesia, banks are categorized based on core capital values, namely Banks Book I, II, III and, IV. The book level of the bank has an impact on business activities and financial ratios imposed by the regulator. In this study, a mathematical model will be devoted to Bank Book III, as a case study.

II. Proposed Methodology

A. Indonesian Banking

Banks are financial institutions that provide services in the form of loans, currency exchange, currency supervision, storage of valuables, corporate financing, and others (Dendawijaya, 2008). Banks become financial intermediaries between surplus spending units and deficit spending units to improve the economic welfare of the community. OJK Regulation 06/POJK.03/2016 Section 3 business activities and office networks classify banks based on their core capital by an impact on their operations actions. Based on their activities, commercial banks are divided into four categories:

1) BUKU 1, with core capital up to less than one trillion rupiahs;
2) BUKU 2, with core capital of at least one trillion rupiahs up to less than five trillion rupiahs;
3) BUKU 3, with core capital of at least five trillion rupiahs up to less than thirty trillion rupiahs;
4) BUKU 4, with core capital of at least thirty trillion rupiahs.

Banks Buku 1 are only allowed to engage in general banking activities in rupiah and act as money changers. In contrast, those with Buku 2, 3, 4 are authorized to engage in rupiah and foreign currency banking activities with a broader scope, capital participation in non-financial institutions for credit rescue, capital participation in other financial institutions for credit rescue and others.

There are twelve banking risks [3]: credit risk, market risk, liquidity risk, operational risk, legal risk, reputation risk, strategic risk, return risk, investment risk, intra-group transaction risk, and insurance risk. Banking risk is complicated, so great attention is needed, as well as the role of the regulator as a banking supervisor. The application of banking supervision by regulators is reflected in the implementation of the Basel Framework by adjusting the conditions and developments in the Indonesian banking industry.

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B. Asset Liability Management

1) Balance Sheet Management: Asset Liability Management (ALM) is the basic model for the analysis of risk margin, value, and liquidity [4]. Activities in Asset Liability Management are planning, organizing, actuating, and controlling to determine managed policies: equity, funding, and assets. Asset Liability Management is reflected in the [5] Balance Sheet Statement structure.

In this study, analysis of the balance sheet structure specifically analysis liquidity risk and market risk in the banking book asset [6].

Activities for implementing liability management assets include [4]:

1) Liquidity Ratio. Financial ratios are effective liquidity ratios that reflect conditions of liquidity risk, relating to the components of assets and liabilities with maturity periods. The liquidity ratio used is usually Primary Reserves, Secondary Reserves, Liquid Assets – Non-Core Deposits, LCR, and NSFR. In its application, each ratio has a threshold value to be applied.
2) Maturity Gap Targets and Ranges. An overview of the difference between the asset's weighted period and the weighted period of liabilities.
3) Funds Placement Guidelines. Determination of the placement of funds on the asset side to obtain the appropriate composition for the liability condition.
4) Foreign Exchange Position, Target and Stop Amount. Determination of position amount, target amount, limit amount of loss and profit, these values need to be determined to maintain security when dealing in foreign exchange.
5) Balance Sheet Structure. Set the balance sheet structure between the composition of each post in assets and liabilities.
6) Earning and Performance Goals. Determination of profit and performance targets to show achievement of profit, financial ratios, and achievement of balance sheet performance.
7) Capital Adequacy. Assessment of capital requirements to determine the development of bank performance.
8) Pricing Policies and Guidelines. Determination of pricing and repricing for each asset and liability component exposed to the risk of changes in interest rates, as a gap control step

2) Liquidity Risk: Potential risk due to the risk of cash flow shortages as a result of poor asset management. Bank liquidity will improve if it provides short-term loans that can be disbursed on their own. Measurement of liquidity risk based on:

1) Liquidity Coverage Ratio (LCR), ranks asset levels based on asset quality. Calculation of asset quality uses a haircut level of 0% to 100%.
   LCR formulation,
$$100\% \leq \frac{HQLA}{CashOutflow - CashInflow}$$
$$100\% \leq \frac{HQLA}{TotalNetCashOutflow}$$
   where, HQLA represents High-Quality Liquid Asset, asset classification level 1, 2A, 2B thus POJK No. 42/POJK.03/2015; Cash Outflow represents Cash outflow in the next 30 days, classifying outflow weights accordingly POJK No. 42/POJK.03/2015; Cash Inflow represents Cash inflow in the next 30 days, classifying inflow weights thus POJK No. 42/POJK.03/2015.
2) Net Stable Funding Ratio (NSFR), measuring stability based on asset categories, is called Required Stable Funding (RSF), with a multiplier of 5% to 100%.
   NSFR formulation,
$$100\% \leq \frac{ASF}{RSF}$$
   where, ASF represents Available Stable Funding, component of assets in balance sheets, categorized based POJK No. 50/POJK.03/2017; RSF represents Required Stable Funding, component of liability in balance sheets, categorized based POJK No. 50/POJK.03/2017.
3) Aktiva Liquid – Non-Core Deposit (AL-NCD) is a parameter for measuring the availability of liquid assets in covering potential withdrawals of funding liabilities.
   AL – NCD formulation,
$$50\% \leq \frac{AktivaLiquid}{NonCoreDeposit}$$
   where, Aktiva liquid represents the assets in the balance sheet, which can be cashed quickly; and non-core deposit represents the liability of customer deposit in the balance sheet, which has risks taken.
4) Maturity profile, bank liquidity needs for a certain period time. Period time of maturity profile assets and liabilities,
5) Macroprudential Intermediate Ratio (RIM) is the ratio of credit and corporate securities to funding
   RIM formulation,
$$80\% \leq \frac{Loan + CorporateBonds}{CustomerDeposits} \leq 92\%$$
   where, Loan represents the assets on the balance sheet, in the form of loans for credit products; corporate bonds represents the assets in the balance sheet, in the form of ownership of non-bank corporate securities; customer deposit represents the liability in the balance sheet, product current saving account, and time deposits.
6) Giro Wajib Minimum (GWM), determined by Central Bank of the Republic of Indonesia, the minimum amount of funds that must be deposited in the current account. GWM-Averaging calculation show the percentage of funding for placements with Central Bank of the Republic of Indonesia especially the current account.
   GWM Averaging PBI No. 20/3/PBI/2018 policy,
   - 4% of customer deposits, which must be accomplished daily
   - 2% of customer deposits, which must be accomplished in a certain period

How is the bank's activities to get technical and strategic decisions by maximizing its profits by limiting that liquidity risk is to being held to an acceptable level.

TABLE I
BALANCE SHEET STRUCTURE

Balance Sheet			
Assets		**Liabilities**	
Cash Resources	Cash	Deposits	Non-interest bearing
	Interest-bearing deposits		Interest-bearing
Securities	Trading account	Other liabilities	Acceptances
	Available for sale		Bonds
	Hold to maturity		Other residual liabilities
Loans	Corporate loans	Subordinated debts	
	Retail loans	Noncontrolling interests	
	Real estate loans	Shareholder equity	Common shares
Other assets			Preferred shares
			Retained earnings
Total assets		Total liabilities	
Sumber:			

C. Market Risk

Macroeconomic conditions affect market risk, macroeconomic shock cause variations in the value of asset and liabilities. In the banking book asset, market risk impacts on securities portfolios for available for sales. The measurement of market risk in securities for available for sales is the calculation of value at risk.

Value at Risk (VAR) indicates changes in asset value due to economic movements during the holding period h [5]. Value at Risk (VAR) is the maximum potential loss of position within ownership time period at a confidence level [1]. The measurement of value at risk is carried out for each Available for Sale (AFS) position banking book asset exposed to market risk due to economic movements during the holding period (h).

There are three main techniques for measuring VAR [1]:

1) Variance-covariance matrix approach, each instrument is assumed to follow the normal distribution of $N(\mu, \sigma^2)$ on economic movements during the holding period (h).
   Variance-covariance formulation,
   $$VaR_{(1-\alpha),t} = \Phi^{-1}(\alpha)\sqrt{w^T \Sigma w}\sqrt{t}$$
   where $w^T \Sigma w$ represents the weight vector and Σ is a return-variance-covariance matrix; t is the holding period (in days).
2) Monte Carlo Simulation Algorithm studies portfolio movements from the dynamics underlying various factors. Monte Carlo simulations generate random numbers based on the characteristics of historical data to estimate VaR values.
   Monte Carlo formulation,
   $$VaR(1-\alpha)(t) = Wo \times R \times \sqrt{t}$$
   where $Wo \times R$ calculates the assets' terminal prices using geometric Brownian motion and t denotes the holding period (in days).
3) Historical Simulation, measured based on data distribution of changes in market prices, without parameters or other assumptions.
   Historical Simulation formulation,
   $$r_{w,t} = w_1 r_{1,t} + \cdots + w_K r_{K,t}$$
   where w represents the percentage of each instrument in the securities portfolio for available for sale; r represents the rate of return; t represents the holding period (days); $1, \ldots, K$ represents the identification/index of each instrument.

D. Linear Programming

1) Linear Programming Model: Linear programming is the science of operational research to optimize limited resources to achieve goals [7]. Problems solved using linear programming methods are allocation problems, blending problems, transportation problems, and assignment problems. Requirements for using linear programming methods [8].

1) Proportionality, all decision variables are proportional to the value of the decision variable.
2) Additivity, each variable in objective function and constraint is a contribution of each variable.
3) Certainty, each variable is assumed to be constant, although in reality many external factors affect the variable.
4) Divisibility, decision variable can be an integer or fraction number

2) Characteristic of Linear Programming: Linear programming solves optimization problems from maximizing or minimizing objective functions. Calculation of objective functions based on constraints, in mathematical formulations. Some things are characteristic of the formation of linear programming models, among others [8]:

1) Decision Variable is a variable that describes the decision completely.
2) Objective Function is a decision variable that is calculated to be maximized or minimized.
3) Constraints are various restrictions that must be complied, so that the variable value cannot be determined arbitrarily.

TABLE II
MATURITY PROFILE OF BANK LIQUIDITY

	Balance Sheet	31 December 2019	Due Date			
			Overnight s.d. 1 W	...	> 6 M s.d. 12 M	> 12 M
1	Cash					
2	Placements with Bank Indonesia					
3	Placements with Other Banks					
4	Bonds					
	a. Government Bonds					
	1) Hold to Maturity					
	2) Available for Sales					
	3) ...					
	b. Corporate Bonds					
	1) Hold to Maturity					
	2) Available for Sales					
	3) ...					
	c. Others					
5	Loans					
6	Other Receivables					
	a. Security purchased under					
	agreements to resell					
	b. Others					
7	...					
	Total Assets					

TABLE III
MATURITY PROFILE OF BANK LIQUIDITY

	Balance Sheet	31 December 2019	Due Date			
			Overnight s.d. 1 W	...	> 6 M s.d. 12 M	> 12 M
1	Deposits from Customers					
	a. Current accounts					
	b. Saving accounts					
	c. Time deposits					
2	Deposits from Bank Indonesia					
3	Deposits from Other Banks					
4	Surat Berharga yang					
	diterbitkan					
	a. Obligasi					
	b. Subordinasi ***)					
	c. Lainnya					
5	Other Payable					
	a. Securities sold under					
	agreements to repurchase					
	b. Others					
6	...					
	Total Liabilities					
	Total Assets and Liabilities					
	Cumulative					

4) Non-negativity restriction, decision variables always non-negative values. Which means the values for decision variables should be greater than or equal to 0.

3) Linear Programming Formulation: There are three types of integer linear programming [8]:

1) Pure integer linear programming, all integer variables.
2) Mixed integer linear programming, several integer variables.
3) Binary integer linear programming, all variable binary numbers.

The linear programming formulations are as follows. The first component is the objective function.
Maximize

$$Z = c_1x_1 + c_2x_2 + \cdots + c_nx_n$$

TABLE IV
VALUE AT RISK CALCULATION RESULT

Portfolio	VAR Daily	VAR Maximum	Return
Series 1	5.44%	12.17%	27.21%
Series 2	4.31%	9.65%	21.57%
Series 3	4.56%	10.19%	22.79%
Series 4	4.81%	10.75%	24.03%
Series 5	4.72%	10.55%	23.59%
Asumption : Confidence Level 95%			

Constraints:

$$\begin{aligned} a_{11}x_1 + a_{12}x_2 + \cdots + a_{1n}x_n &\geq b_1 \\ a_{21}x_1 + a_{22}x_2 + \cdots + a_{2n}x_n &\geq b_2 \\ &\vdots \\ a_{m1}x_1 + a_{m2}x_2 + \cdots + a_{mn}x_n &\geq b_m \end{aligned}$$

Can be rewritten as:

$$\sum_{i,j=1}^{n,m} a_{ij}x_j \geq b_i$$

In particular,

$$\begin{aligned} i &= 1, 2, \ldots, m \\ j &= 1, 2, \ldots, n \end{aligned}$$

Nonnegativity Constraints

$$x_1, x_2, \ldots, x_n \geq 0$$

The mathematical formulation and data needed will be translated into Lingo 17.0 software to get the decision variable value.

III. METHODOLOGY

A. Research Stage

The research method describes the process sequence which consists of several stages, a series of interrelated processes. Groove method steps to make structured and systematic research, including

1) Identify problems about the causes of problems and solutions to problem-solving.
2) Determine the gap between the issue question of case study bank and science technology.
3) Gather literature studies from several theories that have a direct relationship with the bank's research problems and previous research that is a reference. Next, make a direct observation in the case study bank to determine data on the issue question of the case study object.
4) Collect secondary data from various sources for example journal for reference and literary theory.
5) Collect secondary data from the research object used as a model parameter. The bank object research data used is
   - Information on bank balance sheet assets and liabilities that have matured for the next year. the result is a maturity profile table, explaining the availability of liquidity for the next year
   - Historical inflow outflow of customer funds daily for four years
   - The historical market price of securities to be reasonable for sale, one year
   - Interest rates on earning assets of banks, for example interest rates on corporate bonds at each rating, interbank call money bank rates book I-IV and others
6) Measuring liquidity risk and market risk of banking investment instruments used includes:
   - Maturity profile table, explaining the availability of liquidity for the next year
   - Calculate liquidity risk such as the primary reserve ratio and secondary reserve
   - Calculate market risks, value at risk for securities available for sale
   - Calculate liquidity risk and market risk according to the regulator's policy ratio
7) Create mathematical models to measure market risk and liquidity risk
8) Calculate optimal values using optimization software Lingo 17.0 Description of a model that applies to parameter replacement
9) Analysis of the sensitivity model for existing risks, in the projected parameters, will change for simulation

Conclusions are the main results in the study, in the form of investment instrument allocation of a bank in Book III. To optimize profit bank studies on the acceptance of specific risks.

B. Research Method

Linear programming case study to calculate the optimal value, for the maximum objective function to determine the banking book assets. Value of optimization of mathematical models calculated by using software Lingo 17.0. Result Lingo 17.0, including:

1) Objective value that states maximum income
2) The decision variable indicates the bank's assets to generate maximum revenue points (1)
3) Sensitivity model in the objective function and constraints function

IV. RESULTS AND DISCUSSIONS

Case studies are taken to determine the composition of the asset banking book. Determination of portfolio allocation based on profit optimization on the risks received. The asset banking book portfolio is in the form of a Treasury Bank business unit portfolio, such as placement of funds at the central bank of Indonesia, interbank assets, securities, and others.

A. Problem Description

This case study was taken to determine the value of a bank's asset banking book portfolio. The object of the case study is the design of the 2019 business plan for book bank

III in Indonesia. The mathematical formulation solves the problem of maximum profit on accepted liquidity risk and market risk, to produce a selection of the composition and allocation of the bank's portfolio. The banking book asset portfolio used, among others: placement of funds at Bank Indonesia, placement of interbank funds, reverse repo, securities or foreign instruments. Some banking book assets that have characteristics exposed to market risk the require calculation of value at risk. Based on the tenor of each portfolio, liquidity risk will be measured.

a) Value at Risk: Securities portfolios are available for sale that have characteristics of being exposed to market risk so that VAR values are needed on some products that are possible to have. The following are the results of VAR calculations on five government benchmark bonds:

B. Notation

1) c_i is the interest rate on the portfolio i in units of %
2) d_i is the revenue potential for the portfolio available for sales
3) x_{ijk} is the short term portfolio i, type in one portfolio j, tenor portfolio k
4) y_{ijk} is the securities portfolio i, type in one portfolio j, portfolio tenor k
5) α_{ijk} is the securities portfolio is available for sale i, type in one portfolio j, portfolio tenor k
6) β_{ijk} is the foreign securities portfolio i, type in one portfolio j, portfolio tenor k
7) γ_{ijk} is the asset-backed securities portfolio i, type in one portfolio j, portfolio tenor k

C. Decision Variables

There are five general variables divided into 830 variables:

1) x_{ijk} is the portfolio amount x_{ijk}
2) y_{ijk} is the portfolio amount y_{ijk}
3) α_{ijk} is the portfolio amount α_{ijk}
4) β_{ijk} is the portfolio amount β_{ijk}
5) γ_{ijk} is the portfolio amount γ_{ijk}

D. Objective Function

Project objectives of the bank's business plan are the maximum profit.

Max

$$\left(\sum_{i=1}^{p}\sum_{j=1}^{q}\sum_{k=1}^{r} c_{ijk}x_{ijk}\right)+\left(\sum_{i=1}^{p}\sum_{j=1}^{q}\sum_{k=1}^{r} c_{ijk}y_{ijk}\right)+\left(\sum_{i=1}^{p}\sum_{j=1}^{q}\sum_{k=1}^{r} d_{ijk}\alpha_{ijk}\right)+\left(\sum_{i=1}^{p}\sum_{j=1}^{q}\sum_{k=1}^{r} c_{ijk}\beta_{ijk}\right)+\left(\sum_{i=1}^{p}\sum_{j=1}^{q}\sum_{k=1}^{r} c_{ijk}\gamma_{ijk}\right)$$

where, x, y, α, β, γ are productive assets; c is the interest rate of productive assets; d is the rate of return securities available for sale; i is the classification productive assets; j is the sub classification reductive assets; k is the holding period of productive assets.

E. Constraints

There are nineteen barriers as a reflection of the level of acceptance of market risk and liquidity risk.

$$x_{111} \geq 0.98 \tag{1}$$

$$x_{211} \geq 3.06 \tag{2}$$

$$\sum_{i=4}^{4}\sum_{j=1}^{1}\sum_{k=1}^{2} y_{ijk}+\sum_{i=2}^{2}\sum_{j=1}^{1}\sum_{k=1}^{5} y_{ijk}+\sum_{i=4}^{4}\sum_{j=1}^{2}\sum_{k=1}^{5} x_{ijk}+\sum_{i=1}^{1}\sum_{j=1}^{1}\sum_{k=1}^{5}\alpha_{ijk} \leq 1.88 \tag{3}$$

$$\sum_{i=1}^{1}\sum_{j=1}^{1}\sum_{k=1}^{5} d_{ijk}\alpha_{ijk} \leq 0.9 \tag{4}$$

$$\alpha_{ijk} \leq 0.2 \tag{5}$$

$$x_{111}+x_{211}+x_{221}+\sum_{i=2}^{2}\sum_{j=3}^{3}\sum_{k=1}^{5} x_{ijk}+\sum_{i=3}^{3}\sum_{j=1}^{4}\sum_{k=1}^{5} x_{ijk}+\sum_{i=4}^{4}\sum_{j=1}^{2}\sum_{k=1}^{5} x_{ijk}+\sum_{i=1}^{1}\sum_{j=1}^{1}\sum_{k=1}^{2} y_{ijk}+\sum_{i=4}^{4}\sum_{j=1}^{1}\sum_{k=1}^{5} y_{ijk}+\sum_{i=2}^{4}\sum_{j=1}^{3}\sum_{k=1}^{5} y_{ijk}+\sum_{i=5}^{5}\sum_{j=1}^{4}\sum_{k=1}^{5} y_{ijk}+\sum_{i=6}^{6}\sum_{j=1}^{4}\sum_{k=1}^{5} y_{ijk}+\sum_{i=7}^{8}\sum_{j=1}^{3}\sum_{k=1}^{5} y_{ijk}+\sum_{i=1}^{1}\sum_{j=1}^{1}\sum_{k=1}^{5}\alpha_{ijk}+\sum_{i=1}^{2}\sum_{j=1}^{3}\sum_{k=1}^{5}\beta_{ijk}+\sum_{i=3}^{3}\sum_{j=1}^{1}\sum_{k=1}^{5}\beta_{ijk}+\sum_{i=1}^{1}\sum_{j=1}^{1}\sum_{k=1}^{5}\gamma_{ijk} \leq 23.01 \tag{6}$$

$$\sum_{k=1}^{5} x_{23k}\sum_{k=1}^{5} x_{41k}+\sum_{k=1}^{5} x_{42k}\sum_{k=1}^{2} y_{11k}+\sum_{k=1}^{5} y_{21k}+\sum_{k=1}^{5}\alpha_{11k} \geq 8.3 \tag{7}$$

$$\sum_{i=3}^{3}\sum_{j=1}^{1}\sum_{k=1}^{5} y_{ijk}+\sum_{i=6}^{6}\sum_{j=1}^{4}\sum_{k=1}^{5} y_{ijk} \geq 6.48 \tag{8}$$

$$\left(\sum_{i=1}^{2}\sum_{j=1}^{1}\sum_{k=1}^{1} x_{ijk}+\sum_{i=2}^{2}\sum_{j=3}^{3}\sum_{k=1}^{5} x_{ijk}+\sum_{i=1}^{1}\sum_{j=1}^{1}\sum_{k=1}^{2} y_{ijk}+\sum_{i=2}^{2}\sum_{j=1}^{1}\sum_{k=1}^{2} y_{ijk}+\sum_{i=1}^{1}\sum_{j=1}^{1}\sum_{k=1}^{5}\alpha_{ijk}+\sum_{i=1}^{2}\sum_{j=1}^{1}\sum_{k=1}^{5}\beta_{ijk}+0.85\left(\sum_{i=1}^{2}\sum_{j=2}^{2}\sum_{k=1}^{5}\beta_{ijk}+\sum_{i=3}^{3}\sum_{j=1}^{1}\sum_{k=1}^{5} y_{ijk}+\sum_{i=4}^{4}\sum_{j=3}^{3}\sum_{k=1}^{5} y_{ijk}+\sum_{i=6}^{6}\sum_{j=3}^{4}\sum_{k=1}^{5} y_{ijk}\right)+0.75\left(\sum_{i=1}^{1}\sum_{j=1}^{1}\sum_{k=1}^{5}\gamma_{ijk}\right)+0.5\left(\sum_{i=6}^{6}\sum_{j=1}^{2}\sum_{k=1}^{5} y_{ijk}\right) \geq 86.9 \tag{9}$$

$$0\left(x_{111}+x_{211}+\sum_{i=2}^{2}\sum_{j=3}^{3}\sum_{k=1}^{5}x_{ijk}\right)+$$
$$0.05\left(\sum_{i=1}^{1}\sum_{j=1}^{1}\sum_{k=1}^{2}y_{ijk}+\sum_{i=2}^{2}\sum_{j=1}^{1}\sum_{k=1}^{5}y_{ijk}+\right.$$
$$\left.\sum_{i=1}^{1}\sum_{j=1}^{1}\sum_{k=1}^{5}\alpha_{ijk}+\sum_{i=1}^{2}\sum_{j=1}^{1}\sum_{k=1}^{5}\beta_{ijk}\right)+$$
$$0.15\left(\sum_{i=1}^{2}\sum_{j=2}^{2}\sum_{k=1}^{5}\beta_{ijk}+\sum_{i=3}^{3}\sum_{j=1}^{1}\sum_{k=1}^{5}y_{ijk}+\right.$$
$$\sum_{i=4}^{4}\sum_{j=3}^{3}\sum_{k=1}^{5}y_{ijk}+\sum_{i=6}^{6}\sum_{j=3}^{4}\sum_{k=1}^{5}y_{ijk}+\sum_{i=4}^{5}\sum_{j=1}^{2}\sum_{k=1}^{3}y_{ijk}+$$
$$\left.\sum_{i=5}^{5}\sum_{j=3}^{4}\sum_{k=1}^{3}y_{ijk}\right)+0.50\left(\sum_{i=1}^{1}\sum_{j=1}^{1}\sum_{k=1}^{5}\gamma_{ijk}+\right.$$
$$\sum_{i=3}^{3}\sum_{j=1}^{4}\sum_{k=1}^{5}x_{ijk}+\sum_{i=4}^{4}\sum_{j=1}^{2}\sum_{k=4}^{4}y_{ijk}+\sum_{i=5}^{5}\sum_{j=1}^{4}\sum_{k=4}^{4}y_{ijk}\Bigg)+$$
$$\left(\sum_{i=4}^{4}\sum_{j=1}^{2}\sum_{k=5}^{5}y_{ijk}+\sum_{i=5}^{5}\sum_{j=1}^{4}\sum_{k=5}^{5}y_{ijk}+\sum_{i=7}^{8}\sum_{j=1}^{3}\sum_{k=1}^{5}y_{ijk}\right)$$
$$\leq 41.65 \tag{10}$$

$$x_{111}+\sum_{i=2}^{2}\sum_{j=1}^{2}\sum_{k=1}^{1}x_{ijk}+\sum_{i=2}^{2}\sum_{j=3}^{3}\sum_{k=1}^{5}x_{ijk}+$$
$$\sum_{i=3}^{3}\sum_{j=1}^{4}\sum_{k=1}^{4}x_{ijk}+\sum_{i=4}^{4}\sum_{j=2}^{2}\sum_{k=1}^{4}x_{ijk}\geq 11.5 \tag{11}$$

$$\sum_{i=3}^{3}\sum_{j=1}^{4}\sum_{k=5}^{5}x_{ijk}+\sum_{i=4}^{4}\sum_{j=1}^{2}\sum_{k=5}^{5}x_{ijk}+y_{111}\leq 2.15 \tag{12}$$

$$\sum_{i=2}^{3}\sum_{j=1}^{1}\sum_{k=1}^{1}y_{ijk}+\sum_{i=4}^{4}\sum_{j=1}^{3}\sum_{k=1}^{1}y_{ijk}+\sum_{i=5}^{6}\sum_{j=1}^{1}\sum_{k=1}^{1}y_{ijk}+$$
$$\sum_{i=7}^{8}\sum_{j=1}^{3}\sum_{k=1}^{1}y_{ijk}+\sum_{i=1}^{2}\sum_{j=1}^{2}\sum_{k=1}^{1}\beta_{ijk}+\beta_{311}+\gamma_{111}\geq 2.38 \tag{13}$$

$$\sum_{i=2}^{3}\sum_{j=1}^{1}\sum_{k=1}^{1}y_{ijk}+\sum_{i=4}^{4}\sum_{j=1}^{3}\sum_{k=1}^{1}y_{ijk}+\sum_{i=5}^{6}\sum_{j=1}^{1}\sum_{k=1}^{1}y_{ijk}+$$
$$\sum_{i=7}^{8}\sum_{j=1}^{3}\sum_{k=4}^{4}y_{ijk}+\sum_{i=1}^{2}\sum_{j=1}^{3}\sum_{k=4}^{4}y_{ijk}+\sum_{i=1}^{2}\sum_{j=1}^{3}\sum_{k=4}^{4}\beta_{ijk}+$$
$$\sum_{i=3}^{3}\sum_{j=1}^{1}\sum_{k=4}^{5}\beta_{ijk}+\sum_{i=1}^{1}\sum_{j=1}^{1}\sum_{k=4}^{5}\gamma_{ijk}+\sum_{i=2}^{3}\sum_{j=1}^{1}\sum_{k=5}^{5}y_{ijk}+$$
$$\sum_{i=4}^{4}\sum_{j=1}^{3}\sum_{k=5}^{5}y_{ijk}+\sum_{i=5}^{6}\sum_{j=1}^{4}\sum_{k=5}^{5}y_{ijk}+\sum_{i=7}^{8}\sum_{j=1}^{3}\sum_{k=5}^{5}y_{ijk}+$$
$$\sum_{i=1}^{2}\sum_{j=1}^{3}\sum_{k=5}^{5}\beta_{ijk}\geq 3.59 \tag{14}$$

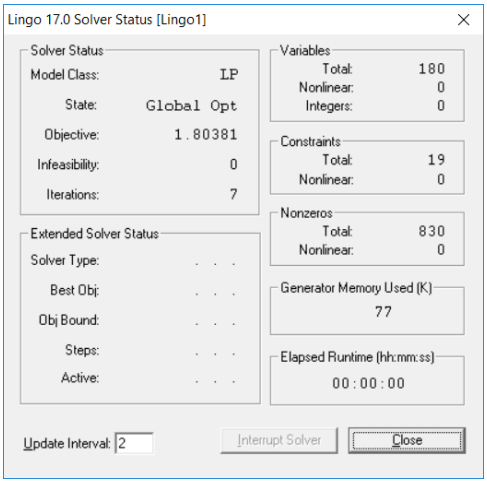

Fig. 1. Full Model Analysis Result.

where x, y, α, β, γ are productive assets; i is the classification of productive assets; j is the sub classification of reductive assets; k is the holding period of productive assets.

Description of mathematical formulation:

- Constraint (1) shows the daily liquidity needs of cash as branch supplies and Automated Teller Machines (ATM)
- Constraint (2) is a deposit of Central Bank of Indonesia for the first buffer of liquidity needs
- The measurement of the risk of banking book asset quality (3), which is supported by the financial ratio of liquid assets compared to non-core deposits
- The limit for measuring market risk in a banking book asset is reasonable for sales (4), which is limited by capital
- Market risk limits for banking book assets are reasonable for sales (5), with the diversification of instruments
- The maximum limit of banking book assets as balance sheet management (6), especially asset management
- The second buffer is liquidity risk in the form of ownership of government bonds productive assets or the Central Bank of Indonesia certificate (7)
- Constraint shows the function of banks as macro prudential intermediaries (8), the measurement of non-finance corporate bonds and credit
- The limit for measuring liquid assets belongs to the buffer potential of net cash outflows in the short term (9)
- Measurement of the need for long-term stable funding sources through weighting methods (10)
- Showing tire liquidity requirements for the next year which are calculated in the position of the maturity profile (11)-(14)

F. Result

Linear programming case study with the maximum objective function, to determine the composition of a banking book asset:

The problem is the global optimum solution with a value of 1,803,810,000 through seven iterations, with a decision variable:

TABLE V
BALANCE SHEET STRUCTURE LINEAR PROGRAMMING MODEL

Balance Sheet	Amount
Cash	988.000.000.000
Current Account with Central Bank of Indonesia	3.055.650.000.000
Term Deposit	6.320.000.000.000
Interbank Call Money tenor 8-11 days	1.186.350.000.000
Certificate of Central Bank of Indonesia	2.150.000.000.000
Government Bonds	1.830.000.000.000
Non-Financial Corporate Bonds Rating BBB	550.000.000.000
Non-Financial Corporate Bonds Rating A	5.930.000.000.000
Government Bonds for Available for Sales in five instrument	1.000.000.000.000
Total	22.022.000.000.0000

TABLE VI
BASIC VARIABLE FOR SENSITIVITY ANALYSIS

Variable	Value	Reduced Cost
A111	0.9880000	0.000000
A211	3.055650	0.000000
A235	6.320000	0.000000
A313	1.186350	0.000000
B111	2.150000	0.000000
B211	1.830000	0.000000
B611	0.5500000	0.000000
B625	5.930000	0.000000
C111	0.2000000	0.000000
C112	0.2000000	0.000000
C113	0.2000000	0.000000
C114	0.2000000	0.000000
C115	0.2000000	0.000000

Sensitivity analysis of linear programming model in the form of sensitivity analysis of objective function and constraint function. The sensitivity level of the objective function is reflected in the type of variable after running Software Lingo 17.0, and there are two types of variables: basic variables and unbasic variables. Changes in the objective function parameters on the base variable affect the optimum value. Following is a list of base variables:

The sensitivity level of the constraints function is reflected in the slack/surplus value and dual prices on the Lingo

V. CONCLUSIONS

The development of bank business plans using the linear programming method manages liquidity risk and market risk there are measured in financial ratios. The usefulness of linear programming methods is to show the threshold of profitability and risk, to optimize profits in the threats that have been received. This research shows the maximum profit that can be achieved IDR against certain liquidity risks and market risks.

TABLE VII
SLACK VALUE AND DUAL PRICES FOR SENSITIVITY ANALYSIS

Row	Slack or Surplus	Dual Price
1	1.803809	1.000000
2	0.000000	-0.1760000
3	0.000000	-0.1235000
4	3.099600	0.000000
5	0.7933800	0.000000
6	0.000000	0.2011000
7	0.000000	0.1447000
8	0.000000	0.1569000
9	0.000000	0.1693000
10	0.000000	0.1649000
11	0.000000	0.1870000
12	0.000000	-0.1160000
13	0.000000	-0.1000000
14	9.904650	0.000000
15	40.80783	0.000000
16	0.000000	-0.1100000E-01
17	0.000000	-0.7000000E-02
18	0.000000	-0.6000000E-02
19	2.340000	0.000000

The results of this study explain the profit that can be achieved by IDR 1.803.809.000.000,- For the profit target, the bank must allocate banking book assets IDR 22.022.000.000,-.

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