

## **Designing a Mathematical Model of Asset and Liability Management Using Goal Programming in Eghtesad-e-Novin Bank**

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**Abstract:** A weakness in the banking system is to equip the resources and optimized allocation of those resources. In that way, the balance sheet management is specifically important. But the management policies and legal limitations whose purpose is to create a balance among the conflicting objectives of profitability, liquidity and risk in banks, would make the bank's balance sheet management a kind of complicated program. The best way to fix this problem is using the multi-objective decision-making models. The objective of the present study is to design a mathematical model of asset-liability management using goal programming in Eghtesad-e-Novin Bank. Using the analytic hierarchy process technique, the financial statements information relevant to the fiscal year 2005-2014 and the legal requirements for that aim, the Goal Programming Model was designed according to the structural restrictions, goal restrictions and the objective function for the optimal allocation of resources to consumptions and it was solved using LINGO Software. The results suggest that the importance degree of objectives was determined by using the analytic hierarchy process technique, the conflicting objectives, requirements and policies were combined and satisfied and the optimal combination of balance sheet items was specified.

**Key words:** Asset and liability management, analytic hierarchy process, goal programming, Eghtesad-e-Novin Bank, LINGO Software

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### **INTRODUCTION**

Commercial banks are the intermediaries providing financial services to individuals and institutions. Their major role is to draw funds from a number of sources and allocate them to a number of uses and the management of this process is one of the most important elements of a bank's strategic planning process. However, involvement of bank managers in several conflicting objectives as increased profitability, decreased risk, development and improvement of facilities and liabilities would complicate the programming process (Giokas and Vassilogloo, 1991).

Some restrictions as the levels of facilities and deposits, reservations, legal requirements, etc., may cause the managers of financial institutions and especially the banks to be in search of finding a technique for programming, controlling and predicting to make them able to meet the expectations of shareholders and depositors as well.

With regard to the rapid changes in technology, variety of banking operations and increased competitions, banking has recently become more complicated. The success of a bank, especially in the conditions of economic instability, depends on the quality of asset and liability management in addition to the management of other variables.

The Asset and Liability Management (ALM) involves a series of technical methods and tools which contemplate value creation for stakeholders and risk management and since ALM is one of the main duties of the chief financial officers in banks, the banks use ALM techniques in order to increase profits with constant monitoring of risk to minimize the losses arising from their transactions.

The most widely used technique presented in the area of ALM is Goal Programming (GP) which combining the sensitivity analysis and stimulation techniques in providing various and optimized combinations to create a perspective of the best

combinations of assets and liability has been the most successful comparing with other techniques.

The main objective of the present study is designing the mathematical model of the asset and liability management using the goal programming in Eghtesad-e-Novin Bank. To consider the legal requirements, policies and multiplicity of objectives of managers and through resolving the model whose aim is indeed to find the optimal combination and size of the balance sheet items concerning the observational regulations, applying the policies and the minimal adverse deviations from the number of goals of directors become evident. With applying this model in the credit and finance institutions we can take a step to increase profitability, risk management, increase the shareholders' value, institution competitiveness, etc.

**Literature review:** ALM Models can be deterministic or probabilistic. The definite models which are utilized in a wide range of problems with assuming certain values for accidental events, apply the linear programming. The Linear Programming Model of Charnes and Chamberis pioneer in the field of asset and liability management. The Probable Models were presented from 1970 and involved utilizing the random constraint programming, dynamic programming, sequential decision theory and stochastic linear programming in terms of uncertainty which present difficult calculations and often originate from portfolio selection theory of Markowitz (Kosmidou and Zopounidis, 2002).

The most widely used technique in the area of ALM is GP. GP was first invented by Charnes and Cooper and then was developed by Ignizio and Lee.

Using the financial statements information of 1991 from Commercial Bank of Greece, Giokas and Vassilogloo in 1991 designed the Goal Programming Model of asset and liability management with structural restrictions (including equality of resources and consumptions), restrictions on bank policies (including share class of deposits, daily liquidity, facilities) and the objective function. According to the results of the model, all the objectives were met except an increase in deposits and loans.

Using the balance sheet data and the monthly profit and loss statements, Guven and Persentili designed a Linear Programming Model for the bank balance sheet by Guven and Persentili (1997). The objective function was the maximization of the bank

net profit. The restrictions involve liquidity, legal requirements of savings, interest and non-interest incomes, interest and non-interest charges, annual profits, letter of guaranty and the ratio of resources to consumptions. The model in comparison with the actual profit, obtained more profit.

Using the financial statements data of risk averter and risk taker banks, Tektas *et al.* (2005) dealt with designing the GP Model for ALM during the crises in 2000. The structural restrictions include leverage ratio, reserves to total deposits ratios, policy related limitations including liquidity risks, credit and operational risks and goal restrictions including liquidity, capital adequacy, market share of deposits and market share of loans. The model's suggestion was a reduction of liquidity in the risk averter banks and increasing that volume in the risk taker banks in the financial crises.

Using the data of balance sheet and profit and loss statements of Grek Bank of Greece in 2002, Kosmidou and Zopounidis (2008) dealt with projecting an optimized balance sheet in 2006 by the GP Model for 2003. The structural restrictions included the deposit volumes, facility volumes, capital, legal deposits and the total volume of assets. The goal limitations included capital adequacy, liquidity risk, facility and deposit growths, the overall return and the current time-weighted value of assets and liabilities. By making a scenario of the interest rate, the model was designed and by resolving it, 207 optimal solutions which had the highest total return were achieved with regard to the scenarios of interest rate.

## MATERIALS AND METHODS

The objective of the present study is to design a mathematical model of asset and liability management using the goal programming in Eghtesad-e-Novin Bank and to respond the following questions:

- How can we quantitatively measure the importance degree of the desired objectives of management?
- How can we combine the legal restrictions, objectives and policies in the Quantitative Model?
- How can we determine and optimize the allocation of bank assets with regard to the given volume of resources by using the Quantitative Model?

Therefore, according to the objectives, the present study is practical, based on the data type it is consolidated and in terms of implementation it is a quasi-experimental descriptive-analytical study.

In order to design a GP Model at first, the accounting-financial system structure and the relationships existing among the balance sheet items were identified and then with the views of experts in Eghtesad-e-Novin Bank (identifying the most important objectives in the area of ALM and determining their degree of importance through the analytic hierarchy process technique (the paired comparisons questionnaire) and using expert choice software), the existing legal requirements and investigation of the financial statements information of the fiscal year 2005-2014 some equations within the structural, goal restrictions and objective function were defined. After being solved by Lingo Software, the bank resources were optimally allocated to the various items of assets (decision variables) and in the end, replacing the actual values of the variables and the parameters of model (using the information in balance sheet ending on March 20, 2014) within the goal restrictions, the results derived from reality were compared to those derived from the model.

### Model designing

#### Introducing the variables of model

**Decision variables:** In this study, all the decision variables ( $x_1-x_{10}$ ,  $y_{13}$ ,  $y_{14}$ ) and the parameters of model ( $y_1-y_{12}$ ,  $y_{15}$ ) have been derived from Eghtesad-e-Novin Bank balance sheet items.

**Deviation variables:** The designed model has 12 positive and negative deviation variables  $d_i^-$ ,  $d_i^+$  ( $i=1, \dots, 6$ ) relevant to the management goals such that  $d_i^+$  represents a positive deviation (over achieved) from the  $i$ th goal value and  $d_i^-$  represents a negative deviation (under achieved) from the  $i$ th goal value. Determining the type of objective (reduced positive or negative deviation from the goal value) it was tried to recognize the adverse deviation variables for each objective.

**Structural restrictions:** There is no possibility to violate such restrictions and the problem response (the values of decision variables) should be applicable to them.

Using the data of financial statements of the fiscal year 2005-2012, the management policies (the values on the right side of the structural restrictions (the maximum and minimum percentages of liabilities and shareholders' equity allocating to the assets) were recognized. The values of model parameters were obtained through using the balance sheet information on March 20, 2014.

**Cash balance ( $x_1$ ):** Introduces the assets with high level of liquidity like banknotes, coins, gold, silver, etc:

$$\begin{aligned} x_1 &\leq 0/012(y_1 + y_3 + y_4 + y_5 + y_6), \\ x_1 &\geq 0/002(y_1 + y_3 + y_4 + y_5 + y_6) \end{aligned}$$

**Receivables from central bank ( $x_2$ ):** The commercial banks are required to keep a proportion of people's deposits in the central bank. The deposits held at the central bank are called legal deposit. According to the rates declared by the central bank for the legal deposit, the weighted average of the legal deposit rate in Eghtesad-e-Novin Bank in 2013 equals 11.8%:

$$x_2 = 0/118(0/95(y_3 + y_4 + y_5 + y_6))$$

**Receivables from other banks and credit institutions ( $x_3$ ):** The interbank loans and deposits are mentioned as the resources for the interim financing of the bank which is the receiver of funds:

$$\begin{aligned} x_3 &\leq 0/15(y_1 + y_2 + y_3 + y_4 + y_5 + y_6), \\ x_3 &\geq 0/3(y_1 + y_2 + y_3 + y_4 + y_5 + y_6) \end{aligned}$$

**Granted facilities ( $x_4$ ):** Sho the most important item of a bank's assets. Bank as the financial supplier would provide the capital needed for the public and private sectors:

$$x_4 \geq 0/68(y_1 + y_2 + y_3 + y_4 + y_5 + y_6)$$

**Bonds ( $x_5$ ):** While providing a guaranteed profit for buyers, the bonds will provide backgrounds for public participation in the long term capital investment projects:

$$\begin{aligned} X_5 &\leq 0/04\left(\sum_{i=1}^{14} y_i\right), \\ X_5 &\geq 0/009\left(\sum_{i=1}^{14} y_i\right) \end{aligned}$$

**Investments (x<sub>6</sub>):** Investment is a kind of asset kept by the investing unit to enhance the economic benefits, enhance the value or other benefits derived from the trade relations:

$$X_6 \leq 0/028(\sum_{i=1}^{14} y_i),$$

$$X_6 \geq 0/012(\sum_{i=1}^{14} y_i)$$

**Accounts and notes receivable (x<sub>7</sub>):** The accounts and notes receivable are the sums the customers are owed to the accounting entity. According to the management policies, 38% at most and 15% at least of the total investment, bonds, facilities and customer commitments for letters to credits as accounts and notes receivable are maintained:

$$x_7 \leq 0/38(x_6+x_5+x_{13}+x_7),$$

$$x_7 \geq 0/15(x_6+x_5+x_{13}+x_7)$$

**Tangiblefix asset (x<sub>8</sub>):** Shows the bank's investment in the physical equipment which is needed to carry out the banking activities:

$$x_8 \geq 0/15(y_{11} + y_{12} + y_{13} + y_{14})$$

**Intangible asset (x<sub>9</sub>):** This asset shows the legal rights which have no physical existence but will bring benefits to the owners in future:

$$x_9 \geq 0/06(y_{11} + y_{12} + y_{13} + y_{14})$$

**Other assets (x<sub>10</sub>):** Are the assets whose liquidity term is longer than a year and often include the intangible assets:

$$x_{10} \geq 0/004(\sum_{i=1}^{14} y_i)$$

**Total bonds and investments:** This restriction is a part of monetary and banking legal requirements of a country. In accordance with paragraph 1 of Article 3 of investment guidelines of the credit institutions, the total investment in securities issued by legal entities should not exceed 40% of the basic capital of the aforementioned credit institution ([www.cbi.ir](http://www.cbi.ir)). The coefficients of variables were determined using the financial statements information of the fiscal year 2013 to 2014 and the existing laws:

$$x_5 + x_6 \leq 0/4(y_{11} + y_{13} + y_{14} + y_{12} + 0/0125(0(x_1 + x_2 + x_5) + 0/2x_3 + 0/5(0/33x_4) + 1(0/67x_4 + x_6 + x_7 + x_8 + x_9 + x_{10})) + 1(0/2(1/017x_{11} - 0/1(1/017x_{11}))) + 0/5x_{12} + 0/5(0/821x_{13} - 0/3(0/821x_{13}))) - 0/059x_6)$$

**Equality of assets, liabilities and shareholders' rights (an accounting equation):** The main feature of an equation is the equality of its two sides which is true in accounting too:

$$\sum_{i=1}^{10} x_i = \sum_{i=1}^{14} y_i$$

**The underlined balance sheet items (y<sub>15</sub>, ..., y<sub>18</sub>) and (x<sub>11</sub>, ..., x<sub>14</sub>):** The underlined balance sheet items would represent the obligations and responsibilities accepted by bank in order to serve the customers. The structural restrictions of these items can be equally regarded as the customer commitments and the bank obligations. The values of bank obligations would enter the model as parameters. The underlined balance sheet items on the side of debts (y<sub>15</sub>, ..., y<sub>18</sub>), respectively include the bank obligations for warranties, other obligations of bank, bank obligations for letters of credit and for the managed funds and similar cases. These items on the side of assets (x<sub>11</sub>, ..., x<sub>14</sub>), respectively include the customer commitments for the warranties, other obligations of customers, the customer commitments for letters of credit and the managed funds and similar cases:

$$x_{11} = y_{15}, x_{12} = y_{16}, x_{13} = y_{17}, x_{14} = y_{18}$$

$$y_{15} = 43538669, y_{16} = 7494649, y_{17} = 8481724, y_{18} = 22032$$

**Liabilities and shareholders' equity (y<sub>1</sub>, ..., y<sub>12</sub>):** These items are involved in the resources of bank funds which should be consumed optimally. This items would enter the model as parameters. These parameters (y<sub>1</sub>, ..., y<sub>12</sub>), respectively include liabilities to the central bank, liabilities to other banks and credit institutions, demand deposits, savings deposits, timeinvestment deposits, other deposits, other accounts payable, tax reservation, dividends payable in stock, reservation of end of service benefits for employees, the capital and assets reevaluation surplus:

$$y_1 = 9003255, y_2 = 9031299, y_3 = 11243225, y_4 = 3405843, \\ y_5 = 225513386, y_6 = 7284294, y_7 = 7141821, y_8 = 545517, \\ y_9 = 6, y_{10} = 228927, y_{11} = 11312000, y_{12} = 0$$

**Retained earnings ( $y_{14}$ ):** Explain the financing from the company's activities as its resource (Bozorgasl, 2011). This restriction has been defined based on Iran accounting standard No. 1, the financial statements information of the fiscal year 2013 to 2014 and the legal requirements:

$$y_{14} = 0/7636(0/269(0/7x_4) + 0/2(1/87x_5) + 0/252(0/87x_6) + \\ 0/21(0/12x_3)0/0088(0/118(0/95(y_3 + y_4 + y_5 + y_6))) - \\ 0/1675(0/83(y_3 + y_4 + y_5 + y_6)) + 1/582(0/16(0/046x_4) + \\ 0/08(0/83x_5) + 0/17(0/13x_6) + 0/06(0/027x_3) + \\ 2/5(0/007(2/12x_{11}) + 0/001(4/2x_{13}))) - 4/131(0/015 \\ (1/064x_4) - 3281940 + 0/024x_4 - 3737368 + 0/06(0/02 \\ (y_1 + y_2 + y_3 + y_4 + y_5 + y_6) + 0/21(0/035y_2))) + \\ 4161843 - 1016359 - 3040000 - 8800$$

**Legal reserve ( $y_{13}$ ):** Legal reserve is for supporting the interests of creditors and corporations. This restriction was defined in accordance with Iran accounting standard No. 1, Article 33 of the country monetary and banking law (according to which Eghtesd-e-Novin Bank would keep 15% of the net profit as the legal reserve), the financial statements information of the fiscal year 2013 to 2014 and the legal requirements:

$$y_{13} = 0/15 \times 0/8984(0/269(0/7x_4) + 0/2(1/87x_5) + \\ 0/252(0/87x_6) + 0/21(0/12x_3 + 0/0088(0/118 \\ (0/95(y_3 + y_4 + y_5 + y_6) - 0/1675(0/83(y_3 + y_4 + \\ y_5 + y_6)) + 1/582(0/16(0/046x_4) + 0/08 \\ (0/83x_5) + 0/17(13x_6) + 0/06(0/027x_3) + \\ 2/5(0/007(2/12x_{11}) + 0/001(4/2x_{13}))) - \\ 4/131(0/015(1/064\%x_4) - 3281940 + \\ 0/024x_4 - 373768 + 0/06(0/02(y_1 + y_2 + y_3 + \\ y_4 + y_5 + y_6) + 0/21(0/035y_2)))) + 2765259$$

where,  $y_{13} \geq 2765259$ .

**Goal restrictions:** Show the desired levels of each objective.

**Liquidity risk:** Is a bank's inability to fulfill its obligations to others in due time (Asadipour, 2007).

Investigating the financial statements information of the fiscal year 2005-2012, it was found that the bank, for avoiding this risk had assigned at least 23% of the deposits to the assets with high liquidity:

$$x_1 + x_2 + x_3 + 0/65x_6 + x_7 + d_1^- - d_1^+ = 0/23(y_3 + y_4 + y_5 + y_6)$$

**Net balance of the fixed assets:** A high share of realities in the bank assets suggests that a high volume of assets in the form of non-incoming assets are not controlled by the management team. In accordance with the letter No. 91/332502/MB of the Central bank (www.cbi.ir), the net ratio of fixed assets to the shareholders equity after deducting retained earning and the unrealized profit should be at most up to 30%:

$$x_8 + x_9 + d_2^- - d_2^+ = 0/3(y_{11} + y_{13})$$

**Facilities growth:** The increased supply of credits may cause an increase in access of the production sector to the inexpensive resources and it can result in production increase and power increase of the manufacturing firms in refunding the trade credits (www.mbri.ac.ir). According to the financial statements information it is predicted that based on the 9-month operation ending on March 20, 2014, the extent of the expected growth for end of period facilities is at least 23% in comparison with the beginning of period:

$$x_4 + d_3^- - d_3^+ = 1/23(157077669)$$

**Facilities to deposits ratio:** This ratio is one of the indicators of credit risk in banks. The Basel Committee standards for the banking system suggest that this ratio should not exceed the boundary of 80%:

$$x_4 + d_4^- - d_4^+ = 0/8(y_3 + y_4 + y_5 + y_6)$$

**Growth of bank share in the joint incomes and honorariums:** The joint incomes are a part of a bank's income obtained through partnership with middlemen. The time deposits of clients, investing the deposits in various businesses and providing time loans for customers have created income for banks which is the result of differences in the interest rates on deposits and granted facilities and the profit derived from investments. In accordance with the financial statements information predicted based on

the 9 months operation ending on March 20, 2014, the extent of the expected growth for the bank share in the joint income and honorarium of the end of period is at least 30% in comparison with the bank share in the joint income and the honorarium of the beginning of the period. The coefficients of variables and parameters were determined by using the financial statements information of the fiscal year 2013 to 2014 and the existing laws:

$$\begin{aligned} &0/269(0/7x_4) + 0/2(1/87x_5) + 0/252(0/87x_6) + 0/21 \\ &(0/12x_3) + 0/0088(0/118(0/95(y_3 + y_4 + y_5 + y_6))) - \\ &0/1675(0/83(y_3 + y_4 + y_5 + y_6)) + d_5^- - d_5^+ = 1/3(5380413) \end{aligned}$$

**The capital adequacy ratio:** The main function of this ratio is protecting the banks against unexpected losses and also supporting the depositors and creditors ([www.cbi.ir](http://www.cbi.ir)). The Basel Committee has recommended that the ratio of base capital to the total weighted assets to the risk coefficients be at least 8%. The coefficients of variables were determined by using the financial statements information of the fiscal year 2013 to 2014 and the existing laws:

$$\begin{aligned} &y_{11} + y_{13} + y_{14} + y_{12} + 0/0125(0(x_1 + x_2 + x_5)) + 0/2x_3 + \\ &0/5(0/33x_4) + 1(0/67x_4 + x_6 + x_7 + x_8 + x_9 + x_{10}) + \\ &1(0/2(1/017x_{11} - 0/1(1/017x_{11}))) + 0/5x_{12} + 0/5(0/821x_{13} - \\ &0/3(0/821x_{13}))) - 0/059x_6 + d_6^- - d_6^+ = 0/08(0(x_1 + x_2 + x_5) + \\ &+ 0/2x_3 + 0/5(0/33x_4) + 1(0/67x_4 + x_6 + x_7 + x_8 + x_9 + x_{10}) + \\ &1(0/2(1/017x_{11} - 0/1(1/017x_{11}))) + 0/5x_{12} + 0/5(0/821x_{13} - \\ &0/3(0/821x_{13}))) \end{aligned}$$

**The objective function:** The objective function in the GP Model would consider the minimization of the adverse deviations from the goals values. After recognizing the adverse deviation variables and applying their coefficients (the importance weight of objectives), the objective function was defined as follows:

$$\begin{aligned} \text{Min}Z = &0/421d_5^- + 0/263d_1^- + 0/143d_6^- + \\ &0/081d_4^+ + 0/064d_3^- + 0/028d_5^+ \end{aligned}$$

## RESULTS AND DISCUSSION

**The results analysis of the model:** According to the results, the value of the objective function is zero which shows the fulfillment of the desired values of all the objectives.

According to Table 1, the model's suggestion is based on the increased allocation of resources to consumptions as cash balance, receivables from other banks and credit institutions, granted facilities, bonds, accounts and notes receivable and also reduction of the values allocated to receivables from the central bank, investments, tangible fix asset, intangible asset and other assets.

According to the results in Table 1, using the model, the balance sheet volume has increased to 1377075.2 million rials this difference has been created without any increase in debts and is the result of an increase in retained earning amounts and legal reserve. According to Table 2 and 3, the results are:

Liquidity risk, facility growth and capital adequacy are the overachieved goals, it means that the positive deviation from the goal value were detected and the achieved value of goal is more than the goal value (the amount of this difference equals the value of positive deviation variable:

$$d_1^+ = 26823718.7, d_3^+ = 4751865.4, d_6^+ = 6728900.8$$

Therefore, according to the suggestion of model: the total amount allocated to the assets with high liquidity is 33.84% of the total deposits, the amount of end of period facilities is 126% of the facilities in the beginning of the period and the bank's base capital is 11.24% of the total weighted assets to the risk coefficients.

In the goals of net balance of the fixed assets, the facility to deposit ratio and the growth of bank share in the joint incomes and honorarium no positive or negative deviations from the goal value were detected. Therefore, according to the model's suggestion: the total amount allocated to the fixed assets is 30% of the shareholder equity after deducting the retained earning and the unrealized profit, the amount of end of period facility is 80% of the total deposits and the bank share in the joint incomes and honorarium of the end of financial period is 130% of the bank share in the joint incomes and honorarium of the beginning of the financial period.

**Comparison of the results of model with the results in reality:** According to Table 1 in comparison with reality. In compliance with the requirements, the model deals with allocation of fewer resources to assets with low return (fixed assets) and investing these amounts in assets with high return

Table 1: Comparison of the real balance sheet values and the balance sheet proposed by the model (figures in million rial)

Assets (x <sub>i</sub> )	The real balance sheet 03/20/2014	Balance sheet based on the model 03/20/2014	The differences in values of the model with the real values	Liabilities and shareholders' equity (y <sub>i</sub> )	The real balance sheet 03/20/2014	Balance sheet based on the model 03/20/2014	The differences in values of the model with the real values
x <sub>1</sub>	1569784	3077400.04	1507616.04	y <sub>1</sub>	9003255	9003255	-
x <sub>2</sub>	27762979	27738780.5	-24198.5	y <sub>2</sub>	9031299	9031299	-
x <sub>3</sub>	37680455	39822195.3	2141740.3	y <sub>3</sub>	11243225	11243225	-
x <sub>4</sub>	194691766	197957398	3265632	y <sub>4</sub>	3405843	3405843	-
x <sub>5</sub>	700000	5610794.38	4910794.38	y <sub>5</sub>	225513386	225513386	-
x <sub>6</sub>	7436892	3532135.27	-3904756.73	y <sub>6</sub>	7284294	7284294	-
x <sub>7</sub>	8029732	10802207.1	2772475.1	y <sub>7</sub>	7141821	7141821	-
x <sub>8</sub>	3967354	3142054.84	-825299.16	y <sub>8</sub>	545517	545517	-
x <sub>9</sub>	5415068	1385925.42	-4029142.58	y <sub>9</sub>	6	6	-
x <sub>10</sub>	5713500	1275714.3	-4437785.7	y <sub>10</sub>	228927	228927	-
-	-	-	-	y <sub>11</sub>	11312000	11312000	-
-	-	-	-	y <sub>12</sub>	0	0	-
-	-	-	-	y <sub>13</sub>	3574661	3781267.4	206606.4
-	-	-	-	y <sub>14</sub>	4683296	5853764.8	1170468.8
$\sum_{i=1}^{10} x_i$	292967530	294344605.2	1377075.2	$\sum_{i=1}^{14} y_i$	292967530	294344605.2	1377075.2
x <sub>11</sub>	43538669	43538669	-	y <sub>15</sub>	43538669	43538669	-
x <sub>12</sub>	7494649	7494649	-	y <sub>16</sub>	7494649	7494649	-
x <sub>13</sub>	8481724	8481724	-	y <sub>17</sub>	8481724	8481724	-
x <sub>14</sub>	22032	22032	-	y <sub>18</sub>	22032	22032	-

Research findings

Table 2: The values of deviation variables (figures in million rial)

Description	Deviation variables											
	d <sub>1</sub> <sup>+</sup>	d <sub>2</sub> <sup>+</sup>	d <sub>3</sub> <sup>+</sup>	d <sub>4</sub> <sup>+</sup>	d <sub>5</sub> <sup>+</sup>	d <sub>6</sub> <sup>+</sup>	d <sub>1</sub> <sup>-</sup>	d <sub>2</sub> <sup>-</sup>	d <sub>3</sub> <sup>-</sup>	d <sub>4</sub> <sup>-</sup>	d <sub>5</sub> <sup>-</sup>	d <sub>6</sub> <sup>-</sup>
Value in model	26823718.7	0	4751865.4	0	0	6728900.80	0	0	0	0	0	0
Value in reality	22964177.76	4916423.7	1486233.0	0	0	4630962.99	0	0	0	3265632.4	1649448/68	0

Research findings

Table 3: Levels of achievement to objectives

Description\Goal (objective)	Liquidity risk	Net balance of the fixed assets	Facility growth	Loans to deposits ratio	Bank's share in the joint incomes and honorarium growth	Capital adequacy ratio
The goal value	23%	30%	123%	80%	130%	8%
The achieved value of goal in reality	32.28%	63%	123.9%	78.68%	99.34%	10.15%
The achieved value of goal in reality (figures in million rial)	79876929.8	9382422	194691766	194691766	5345088.32	21816642.85
Positive deviation from the goal value (d <sub>i</sub> <sup>+</sup> ) in reality	9.28%	33%	0.9%	0%	0%	2.15%
Negative deviation from the goal value (d <sub>i</sub> <sup>-</sup> ) in reality	0%	0%	0%	1.32%	30.66%	0%
Desired deviation from the goal value in reality	9.28%	0%	0.9%	1.32%	0%	2.15%
Adverse deviation from the goal value in reality	0%	33%	0%	0%	30.66%	0%
The achieved value of goal using the model	33.84%	30%	126%	80%	130%	11.24%
The achieved value of goal using the model (figures in million rial)	83736470.74	4527980.22	197957398.4	197957398.4	6994537	23333031.72
Positive deviation from the goal value (d <sub>i</sub> <sup>+</sup> ) in model	10.84%	0%	3%	0%	0%	3.24%
Negative deviation from the goal value (d <sub>i</sub> <sup>-</sup> ) in model	0%	0%	0%	0%	0%	0%
Desired deviation from the goal value in model	10.84%	0%	3%	0%	0%	3.24%
Adverse deviation from the goal value in model	0%	0%	0%	0%	0%	0%

Research findings

(facilities and bonds) which have resulted in the increased income and at last in bank profitability (retained earning) and as a result it would lead in the increased shareholders satisfaction.

According to Table 2 and 3, in comparison with reality in Eghtesad-e-Novin Bank using the GP Model, the desired values of all the objectives were achieved and no adverse deviation from the goal value were

observed and even in the goals of liquidity risk, the facility growth and capital adequacy ratio the value of desired deviation increased. In the facility to deposit ratio goal no deviation were observed in the model, while in reality the desired deviation from the goal value was obtained ( $d_4^- = 1.32\%$ ).

### **CONCLUSION**

One of the most important duties of the financial management is the asset and liability management. Existence of various and sometimes conflicting objectives in this field would support the necessity of using the multi-objective decision making models. The study designs the goal programming model for the optimal management of assets and liabilities in Eghtesad-e-Novin Bank. The results of the study are as follows:

- Designing a quantitative model for the optimal management of assets and liabilities in bank is possible
- Using the GP Model as a decision making tool in ALM while risk is under control, you can increase return
- Using the analytic hierarchy process, the importance degree of the most important objectives in the field of ALM can be quantitatively measured

- Using the GP Model and combining the requirements, policies and conflicting objectives and providing the their desired values, you can identify an optimal combination of the balance sheet items (the determined values of the decision variables are applied in all the structural restrictions and there are no adverse deviations from the goal values (zero value of the objective function) would suggest the ability of model to optimization)

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