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Modifying the resource portfolio and expenses of Iranian bank branches using multi-objective optimization models

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Abstract One of the serious challenges in financial and credit institutions is the reform of the financial portfolio of branches with negative returns. The financial portfolio of banks has a combined structure of deposit attraction and investment, the main purpose of this study is to modify the deposit portfolio and facilities of branches so that the outcome of income and expenses tends towards positive returns.
Inspired by the basic model proposed by Markowitz [1], this study provides a model for financial and credit institutions tailored to their needs. model parameters are: The current portfolio status of a branch, along with other factors that affect portfolio performance. model variables are: Changes that will be made to the numerical values of the initial portfolio to modify the model from negative to positive returns. In order to be able to modify the portfolio in multi-period, the one-period to multi-period model has been developed.
Countries like Iran, where government decisions affect interest rates on deposits and loans, and they have different types of deposits and loans with different rates, it is necessary to establish a logical correspondence between different types of deposits and facilities. The main finding of this research is to provide a model that can improve the branches that have a portfolio with negative returns, with an achievable program, while observing the government and upstream constraints. The proposed models used for the Agricultural Bank of Iran, and the results have been analyzed. The results show that despite the restrictions that banks have to follow the orders of the government and the upstream, they have to create a domestic market and inject some kind of virtual deposit and loans, Reform the portfolio of branches with negative returns.

Keyword: Multi-Period Portfolio, Financial and Credit Institutions, NSGA-II Algorithm, Non-Linear and Multi-Objective Model.

1 Introduction

Inflation rate and bank interest rate are two important and fundamental variables in the economic system and there is a significant positive relationship between these two variables. [2] In recent years, Iran has had an average inflation rate of more than 15 percent, so that in

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certain periods, it has experienced an inflation rate of about 30 percent. On the other hand, Iran is a country with an average bank interest rate of 15 percent, a country with a high bank interest rate. Comparing Iran with other countries with low inflation rates shows that inflation rates and bank interest rates are directly related. In China, the bank interest rate is 4.35%. Saudi Arabia has set a bank interest rate of 2% for bank depositors. In Australia, bank interest rates are 1.5 percent, in Korea 1.25 percent, in the United States 0.75 percent, in Canada 0.5 percent, in Norway 0.5 percent, in the United Kingdom 0.25 percent, in Denmark it is 0.05 percent. Some countries also have negative bank interest rates, in Sweden and Switzerland there are fees for maintaining customer deposits, which is actually a kind of negative interest rate.

The interest rate on bank facilities after the advent of the Islamic Revolution is determined by the Central Bank in accordance with the expansionary and contractionary policies of government liquidity. In the Iranian economic system, there are two general views on the interaction between bank interest rates and inflation. The first view believes that it is necessary to focus on economic indicators to reduce bank interest rates. And the second approach, considering the bank interest rate as a factor affecting other indicators such as inflation and employment, believes that by reducing the bank interest rate, its positive effects can be seen in reducing inflation and increasing employment. Evidence shows that with the passage of the law to rationalize bank interest rates commensurate with the rate of return, in different sectors in 2006, the second approach takes precedence in the current policy environment.

Determining the mandatory interest rate in parallel with its advantages and disadvantages in the economic process of the country has had a special and direct effect on the financial balance of banks. The approach of the deposit interest rate to the facility interest rate has caused the profit margin index to face a serious decrease. (The profit margin is the product of subtracting the average income rate from the facility payment and the average spend rate for attracting deposits). On the other hand, in the Iranian banking system, the low rate of banking services fees prevents the coverage of administrative and personnel costs, therefore, it is necessary to compensate it from the profit margin. If interest rates fall and deposit interest rates approach facility rates, banks will have a serious problem reimbursing their costs.

Given the above conditions, careful and calculated planning to form an efficient portfolio consisting of various types of deposits and facilities with different rates is needed more than ever. In order for banks to have an acceptable return, it is necessary to develop a logical plan for their sub-branches in accordance with the requirements of that branch. In this study, the aim is to provide a mathematical model to orient branches towards positive returns in terms of its risk and compliance with the restrictions set by the Central Bank.

According to what was said, Iran's banking system must always pay attention to the three-pronged management,

1- It is required to conclude monetary contracts with customers, according to the Islamic banking system.
2- To provide the conditions for maintaining the value of customers' money, which is expected by them due to inflation.
3- The financial balance of the bank should not be unprofitable.

Therefore, one of the main challenges of the bank can be described as follows.

1- It is inevitable to use various facility contracts with various interest rates.
2- It is inevitable to attract various types of deposits according to expectations.

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3- It must maintain the limits set by the Central Bank for the payment of facilities from the attracted deposits and simultaneously manage the balance of the interest received from the facility and the interest paid to the depositors, in such a way that the total expenses from the total income does not advance.

These are the questions that this research seeks to find.

• In an economic system where numerous restrictions are imposed on banks by the top management, how can the unacceptable portfolio of branches be corrected?

• How can diversified acceptable portfolios be offered to get out of negative returns?

• For a branch where it is not possible to correct an inefficient portfolio in one time period, how can it be planned to correct the portfolio in several time periods?

2 Theoretical Foundations

In line with the goal of the research, which is to improve the deposit portfolio and branch facilities to control income and expenses towards positive returns, the mathematical models that have been presented so far for this purpose will be mentioned in the following, and at the end, the innovation aspect of the research will be specifically mentioned. Asadi [3] has introduced the formation of a portfolio of assets as one of the methods to reduce investment risk, and for this purpose, the effectiveness of financial ratios to each other using the Dimtel method and network analysis to determine the importance Used indicators and their weight determination. Labbafi et al. [4] has presented a mathematical model for optimizing the assets and liabilities of Bank Melli Iran in conditions of uncertainty, using the deficit planning model approach. Khajehzadeh and Shahverdian [5] with the aim of creating an optimal stock portfolio using the edge regression algorithm, has predicted stock returns and with the aim of achieving an optimal stock portfolio with risk-taking and risk-avoidance tendencies from the cultural meta-innovation algorithm Used. In order to be able to provide a practical portfolio in accordance with the requirements of the Iranian banking system, first, reference is made to the Markowitz model, and research work done to develop this model. In the following, the articles that have been used to solve the models using meta-heuristic methods will be mentioned. Markowitz [1] published his paper on the basic investment portfolio model, which is the basis for the development of financial portfolio optimization models, and at the same time was able to increase the accuracy of decision-making in the investment portfolio. In his model, he used two criteria of return and risk along with budget constraints and proposed variance as a criterion for calculating risk. Then, due to the existence of desirable and undesirable deviations in the nature of variance, he proposed a semi-variance criterion that focused only on undesirable deviations. Sharp (1963) developed a practical application for portfolio optimization. Chen et al.[6] proposed the first multivariate model for stock returns. Barry et al.[7] published papers on the development of the model proposed by Chen et al. Kono and Yamazaki [8] proposed a model based on linear programming for stock portfolio optimization in which they introduced the absolute value of deviations as a criterion for calculating risk in the base model. Speranza [9] introduced a model of mixed planning and applied it to the stock market of Milan, Italy. He used metrics such as transaction costs and

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targeting to minimize trading units. He used the absolute half-value of the deviation as a criterion for calculating risk and designed a meta-heuristic algorithm to solve his model. Chang et al. [10] proposed a parametric and nonlinear model for optimizing the investment portfolio, which due to the second degree of the objective function, had to use evolutionary and meta-heuristic algorithms to solve the model. Mansini et al. [11] presented models for stock portfolio optimization that could be solved by linear programming. Metaxitis [12] proposed a linear programming model for stock portfolio optimization and used evolutionary algorithms to solve the model because the model was designed for multiple purposes. Punic et al. [13] similarly presented a multi-objective function for stock portfolio optimization and used evolutionary algorithms to solve it. Rahmani et al. [14] examined the companies operating in Tehran Stock Exchange from 2005 to 2015 and solved the stock portfolio optimization model using three meta-heuristic algorithms. The results showed that the artificial bee colony algorithm performed better than the ant genetic and algorithm algorithms. Khodamoradi et al. [15] used the MAD model in an uncertain environment to optimize stocks. The models that have been discussed so far are only designed to optimize the investment portfolio. In banks, fund raising operations are carried out in parallel with investment. Attracting deposits and repaying loans is one of the main pillars of investment and forms the basis of the bank's portfolio of resources and expenses. Kiani Ghalehno et al. [16], have presented a new mathematical model, which, by obtaining the number of personnel of a branch and the facility rates, offers various effective portfolios to the branches. The difference in this research is that it aims to correct the portfolio of a branch with a negative return, so considering the current portfolio, according to the requirements of the banks, a correction portfolio has been proposed for that branch. Since the possibility of achieving a positive return for loss-making branches in a one-year period is sometimes far from expected, by developing a single-period model to several periods, it is possible to make step-by-step adjustments.

3 Research Method

This study was conducted with the aim of improving the portfolio of financial and credit institutions and is presented in the form of applied research. First, the factors affecting the returns and the limitations that exist for the portfolio of Iranian banks are identified and listed as follows.

1- Interest rates on deposits and loans are based on the general policies of the Iranian economic system, which are imposed by the Central Bank of Iran.

2- Iran's economic system imposes restrictions on banks for the combination of deposits and loans, including: a certain coefficient of saving-deposit must be paid in the form of interest-free loans. Besides that, a certain percentage of the deposit attracted to the Central Bank is blocked, and the bank attracting the deposit does not have the right to use this amount and only the central bank will reward this amount of the deposit.

3- Observance of financial ratios is mandatory, which is expressed in this research in the form of model limitations. For example, banks are required to have a balance between deposits and

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loans, and if this balance does not exist, to achieve a balance through the domestic interbank market and borrowing.

4- Administrative and personnel costs are other effective factors that have been estimated based on the performance of the branches of the Agricultural Bank of Iran.

NSGA-II algorithm was used to solve the model. The reasons for using the meta-heuristic algorithm in this research are listed below.

- Due to the existence of quadratic equations in the objective function, portfolio models are classified in the group of NP-Hard models and meta-innovative methods are used to solve them.

- One of the advantages of meta-innovative methods is the possibility of calculating the Pareto boundary. To solve the classical method, the problem must be solved several times for different linear combinations. In meta-innovative methods, it is possible to solve a problem with more than one goal, and the solutions at the Pareto border are not superior to each other and according to the needs of the decision maker, they can choose any of the answers. The Pareto border has a set of strategic goals. This is very useful for the portfolio of financial and credit institutions because it will be possible to choose the closest portfolio to suit the conditions and requirements

4 Problem Statement

The main mission of credit financial institutions is to attract liquidity and inject it into the manufacturing sector. Banks incur costs by attracting public deposits and paying various interests to customers, and then earn income by paying facilities and receiving interest from credit customers. Therefore, the financial portfolio of financial and credit institutions can be considered as a combination of capital attraction and investment, which is important to balance the income and expenses of banking operations with other income and non-operating expenses. Naturally, if the bank branches do not have a proper portfolio of deposits and facilities, they will face losses in the financial balance and the need to modify the portfolio is felt. Reforming the portfolio of branches with a negative balance requires a model that offers an efficient portfolio with acceptable returns with the introduction of the current inefficient portfolio and considering the limitations and conditions. Each investment portfolio has two main pillars of return and risk that should be considered in the model. On the other hand, in Iranian banks, due to the existence of inflation and the need to control it, there are mandatory policies regarding the deposit absorption rate and payment of facilities. They are obliged to pay a percentage of Interest-free deposits in the form of Interest-free facilities. Adherence to certain financial ratios, including head-to-head and Sharp-ratios, is another constraint on banks' portfolio compositions. A mathematical model that can meet the described objectives and limitations is the main issue of this research.

4.1 Modeling a Periodic Problem

The variables of the model are the growth rate of different types of deposits and facilities, using the symbols $X = (x_i | i = 1 \dots n)$ &$Y = (y_j | j = 1 \dots m)$. The symbol $XO = (x_{io} | i = 1 \dots n)$ is used for the current values of the deposit portfolio and the symbol $YO = \left(y_{jo} \middle| j = 1 \dots m\right)$ is used to show the current values of the facility portfolio. Buying and selling in the domestic market can be considered as a type of deposit attraction or payment of facilities at a fixed rate, which is the product of the difference between deposits and facilities.

Interest rates on deposits and facilities are problem parameters that use the symbols, $V = (v_i | i = 1 \dots n)$ and $W = (w_j | j = 1 \dots m)$, respectively. Interest rates on deposits and facilities correspond to the different types of deposits and facilities, with index i, j. Income from banking services, administrative and personnel expenses and the balance of non-current receivables are other parameters of the issue.

Table 1 Mathematical model

Index	i	Types of deposits
	j	Types of facilities / loans
parameter	x_{i0}	Amount of initial deposit type i
	y_{i0}	Amount of type j facilities
	v_i	Interest rate paid for type i deposits
	w_j	Interest rate received for type j facilities
	δx_i	Risk aversion of deposit sources type i
	ϑm	The rate of buying or selling a resource in the market
	IF	Banking service fee income
	CF	Fixed costs
	NC	Non-current receivables
Variable	x_i	Deposit amount of type i
	y_j	Amount of facility / loan type j

$$\max \sum_{i=1}^{n} [w_j * (y_{j0} + y_j)] - \sum_{i=1}^{n} [v_i * (x_{i0} + x_i)] - CF + \left[IF * \left(1 + \frac{\sum_{j=1}^{n} y_j - \sum_{i=1}^{n} x_i}{\sum_{j=1}^{n} (y_{j0}) - \sum_{i=1}^{n} (x_{i0})} \right) \right] + 0.001 * \sum_{i=1}^{n} (x_{i0} + x_i) - \vartheta m * \left[\sum_{i=1}^{n} (y_{j0} + y_j) - \left(0.9 * \sum_{i=1}^{n} (x_{i0} + x_i) \right) \right] \quad (1)$$

$$\min \sum_{i=1}^{n} \delta x_i * (x_{i0} + x_i) + 1/n \left[\sum_{i=1}^{n} \left(x_i - 1/n \sum_{i=1}^{n} x_i \right)^2 \right] \quad (2)$$

s.t:

$$y_{10} + y_1 \leq 0.9 * (x_{10} + x_1) \quad (3)$$

$$\frac{\sum_{i=2}^{n} [w_j * (y_{j0} + y_j)]}{\sum_{i=2}^{n} (y_{j0} + y_j)} - \vartheta m \geq \frac{NC}{\sum_{i=1}^{n} I y_j} \quad (4)$$

$$\sum_{i=2}^{n} (x_{i0} + x_i) \left(\frac{\sum_{i=2}^{n} [w_j * (y_{j0} + y_j)]}{\sum_{i=2}^{n} (y_{j0} + y_j)} - \frac{\sum_{i=1}^{n} [v_i * (x_{i0} + x_i)]}{\sum_{i=2}^{n} (x_{i0} + x_i)} \right) \geq CF \quad (5)$$

$$\sum_{i=1}^{n} [w_j * (y_{j0} + y_j)] - \sum_{i=1}^{n} [v_i * (x_{i0} + x_i)] - CF + IF * \left(1 + \frac{\sum_{j=1}^{n} y_j - \sum_{i=1}^{n} x_i}{\sum_{j=1}^{n} (y_{j0}) - \sum_{i=1}^{n} (x_{i0})} \right) + 0.001 * \sum_{i=1}^{n} (x_{i0} + x_i) - \vartheta m * \left[\sum_{i=1}^{n} (y_{j0} + y_j) - \left(0.9 * \sum_{i=1}^{n} (x_{i0} + x_i) \right) \right] \geq 0 \quad (6)$$

$$x_{\mathrm{F}} \geq 0 , y_{\mathrm{F}} \geq 0 , \; x_i \geq 0 \; for \; i = 1, .., n , y_j \geq 0 \; for \; j = 1, .., m \quad (7)$$

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Objective function 1- Used to maximize efficiency. The sentences are as follows.

- Sentence 1: calculates the interest received from the payment facility for the entire facility portfolio, including the facility expenditures of the previous portfolio and the desired facility expenditures in the new portfolio.
- Sentence 2: Calculates the interest paid on the attracted deposit for the entire deposit portfolio, including the deposit resources of the previous portfolio and the desired deposit resources in the new portfolio.
- Sentence 3: Fixed costs include administrative and personnel costs.
- Sentence 4: Calculates the fee income for providing banking services by taking into account the coefficient of new resources and expenses.
- Sentence 5: calculates the commission received from the Central Bank for block deposit amounts with the Central Bank
- Sentence 6: Income or expenses from entering the interbank market for sale or purchase, respectively, calculates surplus or deficit resources.

Objective function 2- is used to minimize the risk of return. The sentences are as follows.

- The first sentence: calculates the risk aversion of resources based on the parameters of the problem
- The second sentence: calculates the deviation of the types of deposits that will reduce the possibility of conserving resources.

Constraint 1- It has been used to maintain the appropriateness of Interest-free deposit and Interest-free payment facilities.

Constraint 2 - Used to maintain the Sharp ratio.

Constraint 3 - Used to establish a head-to-head point.

Constraint 4 - Used to maintain positive returns.

4.2 Multi-Period Problem Modeling

To develop a multi-period model, the index t will be added to the problem and the vector X, Y as a matrix will change its nature. The symbols $X = (x_{it}|i = 1 \dots n)$ and $Y = (y_{jt}|j = 1 \dots m)$ were used for the growth variables of deposits and facilities, respectively. Other conditions remain.

Index	i	Types of deposits
	j	Types of facilities / loans
	t	Time period index
parameter	x_{i0}	Amount of initial deposit type i
	y_{i0}	Amount of type j facilities
	v_i	Interest rate paid for type i deposits
	w_j	Interest rate received for type j facilities
	δx_i	Risk aversion of deposit sources type i
	ϑm	The rate of buying or selling a resource in the market
	IF	Banking service fee income
	CF	Fixed costs
	NC	Non-current receivables
Variable	x_{it}	Amount of type i deposit in period t
	y_{jt}	Amount of facility / loan type j in period t

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$$\max \sum_{j=1}^{n} w_j * \left(y_{j0} + \sum_{t=1}^{T} y_{jt}\right) - \sum_{i=1}^{n} v_i * \left(x_{i0} + \sum_{t=1}^{T} x_{it}\right) - CF + IF * \left(1 + \sum_{t=1}^{T}\left(\frac{\sum_{j=1}^{n} y_{jt} - \sum_{i=1}^{n} x_{it}}{\sum_{j=1}^{n}(y_{j0}) - \sum_{i=1}^{n}(x_{i0})}\right)\right) + 0.01 * \left(0.1 * \sum_{i=1}^{n}(x_{i0} + \sum_{t=1}^{T} x_{it})\right) - \vartheta m * \left(\sum_{i=1}^{n}(y_{j0} + \sum_{t=1}^{T} y_{jt}) - \left(0.9 * \sum_{i=1}^{n}(x_{i0} + \sum_{t=1}^{T} x_{it})\right)\right) \quad (1)$$

$$\min \sum_{t=1}^{T}\sum_{i=1}^{n} \delta x_i * (x_{i0} + \sum_{k=1}^{t} x_{ik}) + \sum_{t=1}^{T} 1/n \left(\sum_{i=1}^{n}\left(x_{it} - 1/n \sum_{i=1}^{n} x_{it}\right)^2\right) \quad (2)$$

s.t:

$$y_{10} + \sum_{k=1}^{t} y_{1k} \leq 0.9 * \left(x_{10} + \sum_{k=1}^{t} x_{1k}\right) \qquad for\ t = 1..T \quad (3)$$

$$\frac{\sum_{i=2}^{n}[w_j * (y_{j0} + \sum_{k=1}^{t} y_{jk})]}{\sum_{j=2}^{n}(y_{j0} + \sum_{k=1}^{t} y_{jk})} - \vartheta m \geq \frac{NC}{\sum_{i=1}^{n} y_{j0}} \quad for\ t = 1..T \quad (4)$$

$$\sum_{i=2}^{n}(x_{i0} + \sum_{k=1}^{t} x_{ik})\left(\frac{\sum_{i=1}^{n}[w_j * (y_{j0} + \sum_{k=1}^{t} y_{jk})]}{\sum_{j=1}^{n}(y_{j0} + \sum_{k=1}^{t} y_{jk})} - \frac{\sum_{i=1}^{n}[v_i * (x_{i0} + \sum_{k=1}^{t} x_{ik})]}{\sum_{i=1}^{n}(x_{i0} + \sum_{k=1}^{t} x_{ik})}\right) \geq CF \quad (5)$$

$$\sum_{j=1}^{n} w_j * y_{jt} - \sum_{i=1}^{n} v_i * x_{it} + IF * \left(\frac{\sum_{j=1}^{n} y_{jt} - \sum_{i=1}^{n} x_{it}}{\sum_{j=1}^{n}(y_{j0}) - \sum_{i=1}^{n}(x_{i0})}\right) + 0.001 * x_{it} - \vartheta m * \left(\sum_{i=1}^{n} y_{jt} - 0.9 * \sum_{i=1}^{n} x_{it}\right) \geq \left(\sum_{j=1}^{n} w_j * y_{j0} - \sum_{i=1}^{n} v_i * x_{i0} - CF + IF + 0.001 * x_{i0} - \vartheta m * \left(\sum_{i=1}^{n} y_{j0} - 0.9 * \sum_{i=1}^{n} x_{i0}\right)\right)/T \quad (6)$$

$$x_F \geq 0\ ,\ y_F \geq 0\ ,\ x_i \geq 0\ for\ i = 1,..,n\ , y_j \geq 0\ for\ j = 1,..,m \quad (7)$$

4.3 Problem solving method

Chromosomes include types of deposits, types of payment facilities and the difference between the total amount of deposits and facilities. The second part is to show the main goals of the problem, namely return and risk control. The third section will be used to perform clustering and member ranking operations using the NS algorithm.

The combination of vectors has been used to encode genomes. In fact, the group of genes that can be developed will be located in the vector, and there will be the ability to increase or decrease the number of this group of genes in chromosome design. This design method, in addition to supporting random changes, is also effective in displaying the answer. Each chromosome is a structure with 8 fields.

- Field 1: the vector dimensional m, each dimension of which is the amount of one type of deposit.
- Field 2: the vector dimensional n, each dimension of which is the amount of one type of facility.

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- Field 3: is an integer value that is the difference of the algebraic sum of the first and second dimensions.
- Field 4: display the values of the objective function.
- Field 5: An integer value and displays the cluster rank of the chromosome Defeated by the other clusters.
- Field 6: is a vector required for NS algorithm calculations and represents the set of chromosomes from the population that is defeated by this chromosome.
- Field 7: An integer required for the NS algorithm and shows the number of times this chromosome is defeated by other chromosomes.

Field 8: is a decimal number required for the NS algorithm and the numeric value of the operator represents the preference of the members of a cluster

4.4 Case study

To apply the model in the real world, the required information is obtained from the Agricultural Bank and the model is solved. Parameters can be classified into two groups: public and private parameters. General parameters include interest rates on different types of deposits and facilities that underlie the operating profit and loss of branches. These parameters are announced by the Central Bank. At the same time, private parameters include fixed costs, average commission rate received, average cost rate of non-current receivables and current branch portfolio, which is required in proportion to the selection of a branch to modify the portfolio.

Table 2 Problem parameters

Parameter description	Type 1	Type 2	Type 3	Type 4	Type 5
Deposit interest rate (percent)	2	1	10	15	18
Facility / loan interest rate (percentage)	4	10	15	18	21
Fixed rate of financing cost (percentage)					17
Fixed rate of financing income (percentage)					17
Fixed administrative and personnel costs ($)					596
Banking service rate (percentage)					1
Cost rate of non-current receivables (percentage)	1	0	1	1	1
Current deposit portfolio	57734	1465	3571	7419	16261
Current facility portfolio	46234	8645	10512	5299	18425

Table 2 contains the information and parameters used in the model. The model for inefficient portfolio is a branch of Agricultural Bank with deposit amounts of types 1 to 5 and types of facilities 1 to 5. Deposit interest rates and facilities are located in accordance with the requirements of the Agricultural Bank in the definition of different types of facilities. Because

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banks are required to block 10 percent of deposits with the central bank and charge a one percent fee for it, this amount has been used as a payment facility with a 1 percent interest rate on Type 2 facilities. One of the requirements of banks is the proportionality of payment of Interest-free facility with Interest-free deposit. The results obtained by solving the model by NSGA-II algorithm are shown in Table 3.

Table 3 Modified single-period portfolio

	Deposit1	Deposit2	Deposit3	Deposit4	Deposit5
Initial portfolio	57734	1465	3571	7419	16261
Correctional portfolio	268	349	149	142	30
	Facilities1	Facilities2	Facilities3	Facilities4	Facilities5
Initial portfolio	46234	8645	10512	5299	18425
Correctional portfolio	241	94	172	962	710
	market	risk	return		
Initial portfolio	-2665	65707	-779		
Correctional portfolio	-241	57616	116		

The amounts listed in the current portfolio table show the branch with a return of -779 and a risk of 434. After solving the problem using the presented one-period model with portfolio modification, it was able to achieve a return of 116 and almost similar risk. The proposed changes in the amount of funds required to modify the portfolio are typically the submission of a plan to the Agricultural Bank branch to modify an inefficient portfolio to an efficient portfolio. The changes required to convert an inefficient portfolio to an efficient one is shown in Figure 3.

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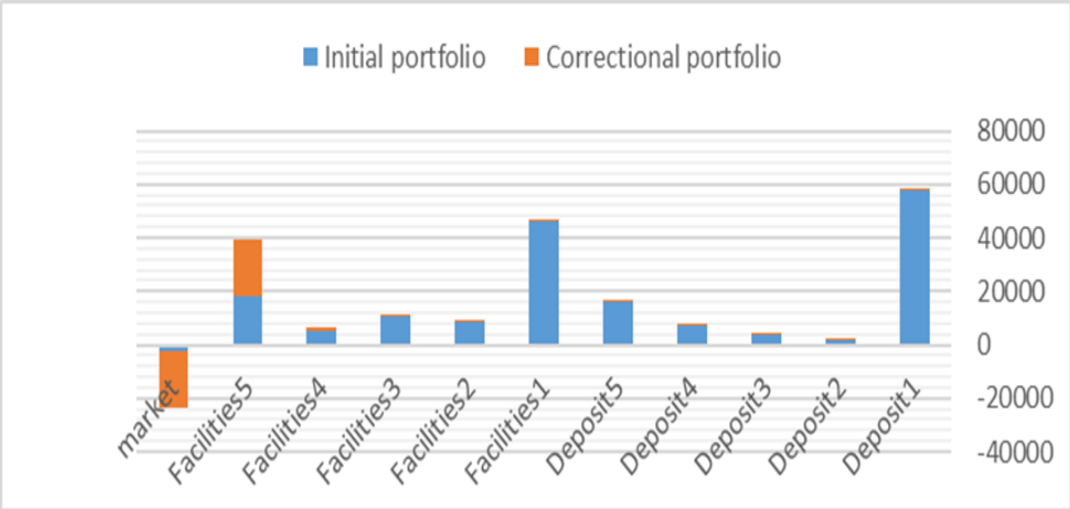

Figure 3 Drawing modified portfolios showing changes

Table 3 contains the proposed portfolio by solving the single-period model, in Table 4 for the parameters described in Table 2 the multi-period model is solved.

Table 4 Multi-period modified portfolio.

	Deposit1	*Deposit2*	*Deposit3*	*Deposit4*	*Deposit5*
Initial portfolio	57734	1465	3571	7419	16261
Correctional portfolio of period 1	84	2129	310	84	294
Correctional portfolio of period 2	134	1781	296	165	521
Correctional portfolio of period 3	313	2153	164	22	230
	Facilities1	Facilities2	Facilities3	Facilities4	Facilities5
Initial portfolio	46234	8645	10512	5299	18425
Correctional portfolio of period 1	77	288	677	3388	49736
Correctional portfolio of period 2	120	288	1157	3002	60217
Correctional portfolio of period 3	282	288	1220	3688	66478

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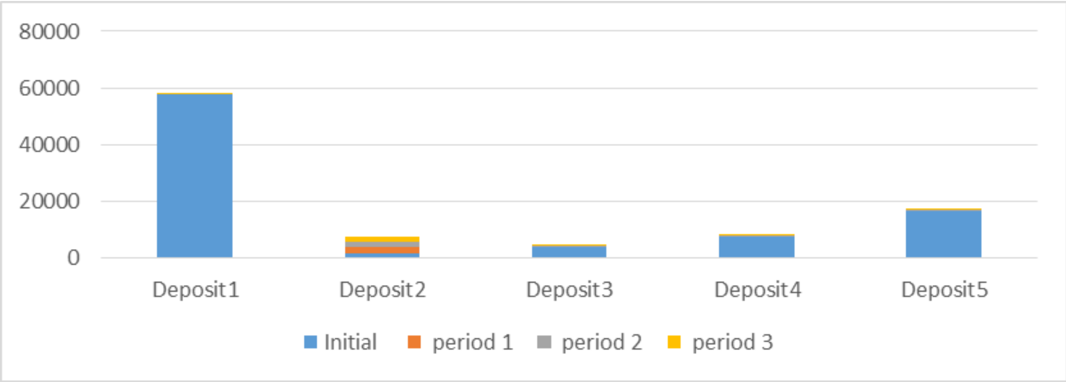

Fig. 4 Drawing a modified deposit portfolio over multi-periods.

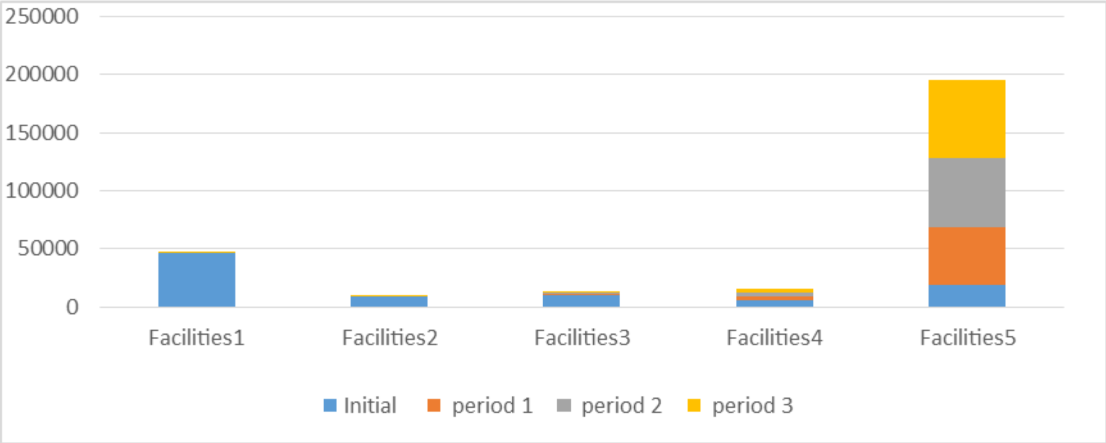

Fig. 5 Drawing a modified facility portfolio over multi-periods.

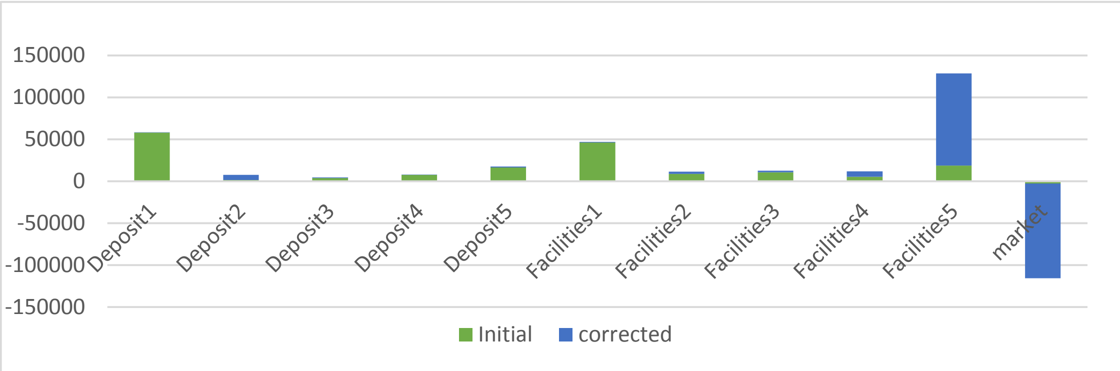

Fig. 6 Show the amount of borrowing from the domestic market

4.5 Discussion

Using the two proposed models, the portfolio of one of the branches of the Bank of Agriculture, which had a negative yield, was modified and an efficient portfolio was

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proposed. Chart 3 shows the correction portfolio for the branch, only in a period of time. Due to the limitations of the Agricultural Bank, the reform of the portfolio depends on the use of the domestic market to attract resources and pay off expensive loans. The root of this issue is two main reasons.

1- Cheap loan payment, which must be matched with cheap deposits.

2- Bank of Agriculture is obliged to freeze legal deposits with the central bank, which is usually a facility with a rate close to zero.

Table 4 and the continuation of Chart 4 show the modification of the branch's deposit portfolio, where the most changes are in short-term deposits. Table 5 and Chart 5 also show the modification of different types of loans. Finally, graph 6 shows the same results as graph 3, with the difference that in three consecutive years, the mounts of changes, in different types of deposits and loans have been determined separately.

5 Conclusions

What this study focuses on is the development of a basic portfolio investment model in the real environment. In financial and credit institutions, several factors affect the return and there are some limitations for the decision maker. The models mentioned in this research are designed in accordance with the needs assessment of Iranian banks and can be developed in accordance with new needs assessments, which is recommended as a suggestion for future research. The branches of a financial and credit institution are divided into two categories of profit and loss. The portfolio of profitable branches is acceptable, but the loss-making branches need to plan and present a suitable and profitable portfolio. In order to balance resources and uses, branches are allowed to enter the domestic market and buy and sell resources at a fixed rate. In order to provide a modified portfolio for loss-making branches, in this research, two mathematical models have been proposed that can correct an inefficient portfolio in one period or several periods and calculate the necessary changes in the branch portfolio to be efficient. Having a variety of strategies gives the decision maker the opportunity to choose the closest portfolio to the current portfolio of the branch. To achieve this goal, an evolutionary algorithm has been used to solve the model. Because: First, for multi-objective functions, it is possible to generate an optimal set of answers that none of the answers can be defeated with other solutions. Second: In the primary society, random answers and operational answers of profitable branches can be used simultaneously and a variety of optimal answers can be produced.

The portfolio of one of the branches of the Bank of Agriculture, which had a negative return, was modified using the two presented models. Efficiency portfolios were suggested. Two serious restrictions in the bank have caused the use of resources from other branches that are offered in the domestic market to be considered as a way to correct the portfolio of the branch with a negative return. The blocking of 10% of the deposits attracted by the central bank and the obligation to pay interest-free facilities from the place of deposit, has practically taken the opportunity of maneuvering to earn profit from some types of deposits from the banks. On the other hand, it should also be noted that, due to the low rate of fees received, practically the income from providing banking services is not enough to cover administrative and personnel costs, and banks are forced to provide it from the facility's income. Results show that due to the limitations of the Agricultural Bank, the reform of the portfolio depends on the use of the domestic market to attract resources and pay expensive facilities.

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