

## Selecting an Optimal Resource Allocation Model to Consumptions in Banks of Iran

Hooman Malek

MA in Planning and Analysis of Economic Systems, Faculty of Economics and Accounting of  
Islamic Azad University, Tehran Central Branch, Tehran, Iran  
Email: Mhoomanmalek@yahoo.com

Ghodratollah Emamverdi

Assistant Professor, Member of Faculty of Economics and Accounting of Islamic Azad  
University, Tehran Central Branch, Theoretical Economics Group  
Email: ghemamverdi@gmail.com

Mina Saheb Kashani

MA in Development economics and Planning, Faculty of Economics and Accounting of  
Islamic Azad University, Tehran Central Branch, Tehran, Iran  
Email: minaskashani@yahoo.com

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### Abstract

The aim of this research is find a model for optimal resource allocation in Banks of iran. So in this study we want to present a mathematical model based on the linear programming models to find the best combination of facilities of resources. For case study in Among the Iranian banks we select The maskan bank. At first look, the banks take action in two fields: one is mobilization of financial resources and the other is resource allocation. Allocation encounters some limitations which affect the model, for example there should be balance between resources and expenditures and the expenditures should not be more than resources, also relative contribution of the sectors should be respected. Here, banks considering credit risk of customers should enforce their facility demands because the loan portfolio management problems, has been the main factor of bank bankruptcy. In the model, facilities are considered as six variables. Using LINDO software can solve the model. At first we have determined the target and then specified the limitations of model and finally wrote the Model. The results of the model were obtained in two forms: with and without into account the resources of Javanan maskan savings fund. The findings showed if mathematical model had been used in the year, the more revenue of facilities was obtained.

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**Keyword:** Portfolio, linear programming, the decision variable

## 1. Introduction

Banking emerged in the world when people began to trade and exchange goods. With trade expansion even when the concept of money was not as what it means today, the need for institutions with banking services became more tangible. The need for institutions that act as means of value payment and measurement especially the receipt demands of near or faraway customers, despite the risk of money transfer was clear, so it led to emergence of banks which do these interactions. In order to survive and provide services, banks needed some ways and strategies to supply their current and fixed costs. One of these ways was to pay the deposits as facilities to other people in exchange for payback and interest. The issue here was how to allocate the resources as facilities, because banks were responsible for the giveback request of depositors and also they wanted to make most of the interest. What we are looking for in this study is the optimal allocation problem!

The task of specialized banks is, in addition to their general role in country's economic system, to supply the financial resources of the projects in economic-social sectors which are their subdivision. Banks, according to some instructions has to pay special facilities to customers but sometimes lack of economy to scale and deferment lead to bank loss in the long run. Therefore presenting a model which based on it, maximum bank profitability could be provided so that they can achieve their home providing goal is important.

## 2. Literature

### 2-1. Portfolio

The word portfolio is interpreted as project basket in the management literature. In risk management literature, this word means share basket. Portfolio risk management means to select that kind of investment (like stock and securities) which decrease investment risk and increase the interest.

Generally natural persons and artificial ones (incorporations) for reducing non-systematic risk of investment proceed to purchase diverse portfolio in various amounts. This diversification could reduce non-systematic risk but it is not able to reduce or eliminate systematic risk. Portfolio is an Italian word and it refers to people who keep their capital/investment in form of set of items that are known as portfolio in bourse. In Iran the idiom "never put all your eggs in one basket" refers to this concept.

For the first time Markowitz in his valuable work, gave a precise definition of what until then was only some vague and rhetoric definition of risk and efficiency. Markowitz defined investment return with expectancy value or mathematical value of investment possible results and defined risk with variance or square deviation of mathematical value. Recognizing risk and return on the basis of mean and variance that is so obvious to financial experts now, was so unclear and unbelievable those times. Even today people consider risk as probable occurrence of loss and not change in productivity. Markowitz recognizing risk and return as mean or variance, created strong statistic determinism for the study of portfolio options. The criticism of his model was that in this model, standard deviation and variance were the only two criteria of productivity while investors usually consider many different criteria when forming portfolio. Liquidity is one of the most important criteria Usually, in portfolio selection investors use productivity, risk and liquidity simultaneously.

In modern portfolio theory, the set of securities is studied by analyzing expected return, risk (changes in expected productivity) and the relationship between members of set of securities (measured by correlated coefficient).

In order to survive and achieve their goals, banks need management and the right resource allocation or in the other words appropriate facility selection. Therefore we engage in definition, goals and the reasons of loan portfolio management for the rest of this paper.

Loan portfolio management includes all the systems and processes that are used for planning, directing, controlling and evaluating bank lending. Loan portfolio management should be able to consider different parts and sectors, united; and this depends on the size of organization, organization structure, organization complications and loan portfolio. Portfolio management parts are as follows:

- Credit policies and procedures
- Credit culture
- Internal controlling system
- Portfolio quality
- Portfolio combination
- Growth and profitability
- Loan approval standards
- Management information systems
- Evaluation

Credit policies and procedures should determine orientations and operation control of various credit levels clearly. Credit policies should be compatible with long run goals and strategic plan and it should be evaluated every year. Credit culture should be based on lending procedures and it should be in the framework of risk management and loan admission standards. Internal portfolio systems protect the goal realization and risk.

### **3. Background**

As mentioned before, optimal resource allocation and achieving the goals such as high profitability and low loss were always considered by managers of financial institutions and banks otherwise problems will raise and even lead to bankruptcy. Therefore finding ways of increasing investment productivity is vital. Studying literature of the field makes us familiar with previous works and their results and it transfers their experiences and theoretical principals. Here we express some studies that are more related to our study.

Ali soori, in a study named "optimal investment allocation in Iran's economic sectors" presents a model based on mathematical programming models for allocating investment in production sectors of Iran's economy. His model is applicable for a while equivalent to second five-year program in Iran. In most cases there are many differences between model results and second program and this may be because of using an econometrics model for second five-year program which was different from optimal models. Saeed Islami Bigdeli in his article titled "modern portfolio theory (MPT)" investigates risk and productivity through modern portfolio and efficiency of Markowitz's. He also investigates diversification of securities. In our study, we mentioned that in portfolio theories combination of securities and their management is investigated. G. Asgarzade in a paper titled "mathematical modeling determining optimal combination of facility portfolio in finance and credit institutions" presents a model for facility portfolio of such institutions because people do not trust these institutions as they do for state finance institutions and banks. People say that Credit risk of credit institutions is high. SaeedJamshidi expressing the ways of facility allocation investigates

credit risk management, profit increase strategies, reducing loss due to lack of optimal resource allocation. Fouad Ben Abdol aziz has presented a programming/planning model with random restriction which in fact is a combination of agreement planning and planning model with random restriction. Ayrgat Matthias et al have used multi-criteria decision approach for portfolio optimization. Multi-objective optimization strategies using genetic algorithms have been used by many researchers. Genetic algorithms are useful for creating efficient boundaries with two or three goals and therefore helping to make decisions based on virtual efficient boundaries. Andrew. W. introduced asset liquidity as one of the most important criteria of investors in the framework of portfolio mean-variance standard optimization. His studies showed that similar portfolios in traditional mean-variance efficient boundaries were so different in terms of liquidity properties. Amyhoyd yakof using a mathematical programming model shows that expected stock return, both cross sectional and over time, has a negative relationship with liquidity. Studies and researches done by Mendelssohn, brennan, sabre ahmnyam, datar et al, Jacobs et al, Paul Marshall, all indicate that there is a negative relationship between liquidity and expected return of assets. These studies show that liquidity is one of the most important factors affecting the portfolio decisions of investors. Such studies have been done for facility portfolio of banks in Iran in recent years and among them we can mention facility portfolio of melli bank, tejarat bank and also private banks like parsian bank and karafarin bank.

#### **4.Methods**

The purpose of this study is to present a mathematical model for finding the best facility combination. Therefore by studying existing mathematical models, we choose, according to conditions and restrictions, the best model and based on it we determine the best facility combination in terms of capital return.

##### ***4-1.Methods for solving portfolio problem***

Markowitz was the first who defined the concept of efficient portfolio. Markowitz's basic model is solved through quadratic planning. Some mathematical models used for portfolio model are as follows:

##### ***4-1-1.Markowitz model***

Markowitz portfolio theory is based on preference. This theory says that investors tend to avoid risk. Also according to this theory the distribution of return of investment projects is normal.

##### ***4-1-2.Multi-objective linear programming model***

The emphasis of classic optimization model is having an object function which can be either linear or non-linear or mixed. But in complex decisions instead of using one optimality measure, several measures might be used which is named multi-objective models.

##### ***4-1-3.Goal programming model***

It is a special kind of linear programming that low-level goals are only considered fulfill high-level goals. In this mode the difference between goals and actual results are minimum.

##### ***4-1-4.Fuzzy linear programming model***

This is a special kind of decision model which solves the problem of definiteness of classic linear programming. Here one can decide to have object function at any level that you want and not just maximum or minimum level.

##### ***4-1-5.Linear programming model***

As mentioned before linear programming is a kind of mathematical programming model that is related to efficient allocation of limited resources to activities in order to achieve the optimum goal. The salient feature of linear programming model is that in such models, functions indicate linear constraints and goals. Many solving methods of non-linear models are based on how linear models estimate them. The model presented in this study is of linear programming models with purpose of maximizing profit according to budget constraints, credit policies and capital adequacy:

$$Max(t) = \sum RETURN_j x_j$$

- 1- The budget constraints
- 2- restrictions on bank credit policies
- 3- Capital Adequacy

Linear programming model is the best applicable model for bank resources portfolio. In Markowitz model risk criteria should be calculated so due to lack of adequate information in maskan bank .this model could not be used for problem solving. Models like goal programming, multi-objective linear programming, and fuzzy linear programming are not applicable in this issue because bank's portfolio has just one goal and there is definiteness in limitations and signs.

What is recommended for formulation is that first you should know the target and then specify the limitations and constraints and finally write the Model.

#### 4-2.formulizing the model

##### 4-2-1.Definition of decision variables

$x_i$  : The amount of awarded facilities in the type of Islamic contracts separation ,  
 $i = 1,2,3,\dots,n$

##### 4-2-2.Definition of model parameters

$t_i$  : The average of the facility rate of the i-type

i: Types of available facility,  $i=1,2,3,\dots$

r: Legal deposit rate

B: All legal deposit

$A_k$  : Total payment facilities available, in the K part

G: Disposable resources

$C_s$  : Fund's liquidity ratio

J: Types of bank deposits

K: the Number of economic sectors

D: The total resources available as facilities

X: The total facilities granted to the banking system according to resources

n: Number of contracts,  $n=7$

$a_k$  : The relative contribution of sectors

I: base Capital

L: Number of short and long term bank deposits,  $L=9$

$\beta$  : Coefficients of risk assets

$R_i$  : Credit risk for each contract

##### 4-3.How to build a mathematical model

**4-3-1. Detection of required limitations**

In this programming model and for allocating optimal bank portfolio we can consider many limitations, each of which affecting the model significantly and even may change the linear programming.

But we try to consider fundamental limitations of the model and make it valid. Such limitations include:

- Facility rates
- The relative contribution of sectors
- Limited resources to pay for facilities
- Legal deposit rate with central bank
- The amount and ratio of resources to expenditures
- Total payment facilities
- Capital adequacy ratio

**4-3-2. The optimal allocation model**

Now we can write optimal allocation model of bank. But first it is necessary to provide a brief description of the model and how it is extracted. As already mentioned our goal is to obtain an optimal point with 6 components  $x, n...2, 1=l$  in the composition of facilities so that the benefit from the total payment facilities would be maximized during the year and when simplifying the model,  $TR=PQ$  can be used for the objective function. Therefore bank like a firm gives baskets of goods (portfolio) as facilities to applicants with a price equal to interest rate. However bank takes additional interest of 6% for deferred facilities from customers, so if facility price is equal to  $t$ , the price of deferred facilities would be  $t+6\%$ . This means that during one fiscal year, bank sells its goods with two prices. So facilities would be divided in two groups: one group is the facilities that their installments are paid in time (in deadline) and the other group is facilities that their installments are deferred for one year. The latter group should pay fine of 6% rate. Deferred facilities percentage  $R$  and the percentage of facilities that are paid in deadline  $1-R$  are entered in the model as index.

Therefore the model for objective function is as follows:

$$Max \sum_{i=1}^n \left[ x_i t_i (1 - R_i) + \frac{x_i R_i (t_i + 0.06)}{1 + t_i} \right]$$

*S.T.*

$$X = \sum_{i=1}^n x_i$$

$$A_k \leq a_k y \quad k = 1, 2, 3$$

$$r \sum_{j=1}^L B_j = B$$

$$G - C_s = D$$

$$X \leq \%70D$$

$$\beta x \leq \frac{I}{\%8} - S \quad \begin{matrix} x_i > 0 \\ R_i > 0 \end{matrix} \quad , \quad j = 1, \dots, L, \quad , \quad i = 1, 2, \dots, n$$

As can be seen, objective function that determines the revenue gained through facility sale is maximum and constraints are minimum; this is consistent with assumptions of linear programming model. For case study, According to the information and statistics available of one of Iranian banks that called maskan bank in 2007 and using the Lindo software the following results are obtained for the objective function.

### 5. Findings

The results of the model were obtained in two forms with and without into account the resources of Javanan maskan savings fund. The first model gives fuller and more reliable results because considering all the resources and consumptions the research model would be more practical. However, in real terms, considering all aspects there is no possibility of eliminating the sources of these accounts.

Taking into account the resources of javanan fund, according to facility amount which is 70% of resources, the extracted model would be as the following:

$$\text{Max } 0.14 x_1 + 0.12 x_2 + 0.12 x_3 + 0.04 x_4 + 0.12 x_5 + 0.11 x_6$$

Subject to

$$1- x_1 + x_2 + x_3 + \leq 52228.16 x_5$$

$$2- x_1 + x_3 + x_5 + \leq 812.67 x_6$$

$$3- x_1 + x_4 + \leq 1083.57 x_6$$

$$4- x_1 + x_2 + x_3 + x_4 + x_5 + \leq 54178.59 x_6$$

$$5 - x_i > 0, \quad i=1,2,3,\dots,6$$

$$6- x_2 \leq 86845.53$$

Thus, using lingo software, objective function value is obtained 6386.937 billion rials if we consider the amount of awarded facilities 51469.660756 billion rials by using purchase variable, 270.892944 by using gharzolhasane variable and 812.678833 by using other variables.

In the above model, the first three constraints were related to the relative contribution of sectors and the fourth constraint was related to the central bank limitation for allocating 70% of resources to the various economic sectors. The fifth limitations were of mathematical programming limitations and finally the sixth constraint was related to the account of maskan savings fund which was previously described.

The results, compared to what bank has gained based on its resource allocation; show over 1000 billion rial revenue difference. So if the allocation was done correctly, this number was added to the income of bank facility within one year. The answers indicate that the model tries to select those contracts which have the highest efficiency and capital return.

If not taking into account the resources of javanan maskan savings fund, the objective function value would be 6201.18 billion rials. This number is obtained only if the purchase facility is 50685.39 billion rials, gharzolhasane facility is 266.89 billion rials and the other facilities are 788.67 billion rials. It has a difference of over 848 billion rial with what was obtained in 2007. This means that if mathematical model was used in the year, the revenue of facilities would be more.

### 6. Sensitivity analysis

Lindo software with solving LP model, also computes REDUCED COST and DUAL COST.

Reduced cost: it shows that if in objective function, RC be added to the coefficient of variable, the variable would be valued. ( for variables that their value is zero, RC is non-zero and for variables that their value is non-zero, RC is zero.)

Dual price: it shows that to what extent objective function improves if one unit is added to the constraint fixed number RHS.

It was observed that in the first case, the value of RC is non-zero for variables  $x_1$ ,  $x_3$  and  $x_5$ .

The analysis of numbers is as follows:

If 0.0882 is added to variable coefficient  $x_1$  and 0.0683 is added to variable coefficient  $x_3$  and 0.0683 is added to variable coefficient  $x_5$ , the value of these variables would be non-zero in the model answer.

It was observed that in the second case, the value of RC is non-zero for variables  $x_1$ ,  $x_3$  and  $x_4$ .

The analysis of numbers is as follows:

If 0.0882 is added to variable coefficient  $x_1$  and 0.06996 is added to variable coefficient  $x_3$  and 0.0683 is added to variable coefficient  $x_4$ , the value of these variables would be non-zero in the model answer.

### **7. Suggestions:**

At the end, for developing research and also achieving more practical results, we express some suggestions:

1. So far the research models and their programming were used for industrial debates and discussions and they were used less for financial debates, investment and banking. So since such models and especially mathematical models with strong theoretical base have had significant application, it is better to use mathematical model for resource allocation in banks. Based on this model, many financial decisions are made as well.
2. Banks using mathematical model can allocate the contracts which are more desirable and efficient in terms of capital return and allocate less the contracts that are not efficient in terms of capital return.
3. Given that, maskan bank is one of the three specialized banks in the banking system of Iran; we suggest that the model be investigated in the other two banks with similar accrual accounts.
4. Maskan bank should establish a working group for managing maskan saving fund account and the purchase facility obtained from the model so that during the year according to the facility awarding process and the demand of depositors this group can determine the appropriate contraction and expansion policies and notify them to bank so that the optimal point can be achieved at the end of the year.
5. The maskan bank uses facilities only in three economic sectors: the housing sector, the industry and mining sector and other sectors. Among these, the greatest facility amount belongs to the housing sector. Although it seems natural because of the specialized bank, but since it has more diverse and efficient portfolio, it is better to be active in other economic sectors as well.

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### **Corresponding Author**

Hooman Malek, MA in planning and analysis of economic systems, Faculty of Economics and Accounting of Islamic Azad University, Tehran Central Branch, Tehran, Iran (Mhoomanmalek@yahoo.com)

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