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OPTIMAL ALLOCATION OF BANK RESOURCES AND RISK REDUCTION THROUGH PORTFOLIO DECENTRALIZATION

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Abstract:

The main concern of all economic companies is the resources equipping and allocating them in different economic sectors with the aim of maximizing profit and minimizing risk. Decentralization is one of the important factors that reduce investment risk. The investors plan to create investment by carefully planning and collecting sufficient information on the economic situation and analyzing the situation of various industries. As an economic enterprise, banks are looking for short- and long-term investments in a types of loans ,such as bailment of a capital , civil participation, reward, etc, which guarantees the return of their capital. In this paper, considering the condition of a bank as an economic enterprise, a model is presented which not only increases profit but also reduces risk. Two objective functions have been defined that the first objective is to minimize the risk and the second objective function is to maximize the of the bank profit, which is used by robust programming and Malvi Sim model. In this paper, we have investigated the Risky and non-Risky Partfolio and the optimal portfolio of bank assets from scenario based solution of the model and by using PSO and Genetic Optimization Algorithm. At all levels of confidence and optimal values of risk based on the estimation of SPP-CVAR method by Particle Swarm Algorithm (PSA) is less than genetic algorithm, which indicates better performance of Particle Swarm Algorithm (PSA) than Genetic Algorithm (GA). Also, the optimum wealth obtained from PSA solution is higher at all levels of confidence than the corresponding value of Genetic Algorithm (GA), and this is another reason to confirm the performance of PSO algorithm compared to the Genetic Algorithm (GA). The values of the first goal function, obtained from the PSO algorithm, for all confidence levels are lower than those of the genetic algorithm. The optimum wealth obtained from PSA is higher than genetic algorithm. At 0.9 level, the value of LR of kupiec statistics for the SPP-CVAR method was less than the Chi-square statistics (Critical value) which was assumed to be acceptable.

Keywords:

Risky and non-risky assets; New portfolio; Bank deposits; Risk ; PSO ; PSA

JEL Classification: G20, G11

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Introduction

Today, compared to various economic sectors, a significant share of the entire economy belongs to the service sector and in the service sector, banks, financial institutions and credit have a significant and distinguished role. Any activity that requires the acquisition of capital and financial resources will undoubtedly require the involvement of economic firms such as banks and financial and credit institutions. Banks are an important and effective part of business and economic activities worldwide. Most people and institutions use banks to deposit or borrow money. Banks play a major role in maintaining public confidence in the monetary system through the close relationship they have with the regulatory authorities and governments, and the regulations that governments have imposed on them. Therefore, there is a great interest in the economic health of banks, especially in the ability to pay commitments, liquidity and relative risk to different operations. In the economy, banks can be considered as the driving force of other sectors that facilitate commercial and commercial transactions by directing and organizing payments and brokering markets and economic growth. They can provide financial support to other economic sectors by collecting surplus and stray capital. In other words, banks have an intermediary role between the borrower and the borrower. Obviously, the main goal of a bank or any other economic unit, in addition to fulfilling social responsibilities, is to increase its value. In order to achieve the main goal of the bank, achieving to increase efficiency and productivity, increase market share, increase profitability, growth and development are considered. Banks are the economic firms that are rooted in the private sector's economy construction, and similar to other production companies in the economy under the programme and aim to maximize profits, they can provide their services to an optimal level. From the founding and shareholders' perspective, the bank is a commercial institution created to earn profits through monetary and credit transactions. In view of this group the bank managers should be aware of the maximum possible interests. In the view of this group, the efforts of bank managers should be made to the best interest possible. Therefore investigating effective factors in the profitability of banks, due to the increasing size of bank branches and increasing growth in private banks and financial and credit institutions across the country, and following that participation in the competitive market is now considered a necessity (Awni, Leila, 2008). One of the requirements for success in investment is to identify the appropriate investment opportunities and allocate resources in those opportunities. One of the investment elements is to prevent waste in resources and to select the appropriate stock. Due to the importance of banking industry in this research, a robust planning model was proposed to design the optimal allocation model of bank resources and reduce risk through parabolic decentralization.

Literature of subject:

Asset management and debt is considered as the process of evaluation and control of company risks to achieve the planned financial goals. This process includes planning, guiding and controlling activities of currents, levels and combinations of funds, as well as spending and company income, and is involved in financial risks control process. Asset management and debt management for all institutions, especially financial institutions, and among them, especially banks, have a special place. Managers always want to know with the help of which the output can be maximum, control the risk and maximize the wealth of shareholders. In this regard, from time to time, it has been tried to present techniques and models in order to identify possible solutions and solutions and help managers in decision making process (Izadi Nia and Amou, 2011). Today, banks in all countries' economies play a major role in implementing monetary policies and have to develop their own large and operational strategies to participate

in competition. The banks' mission is based mainly on the principle that they collect stray funds from society in the form of deposits and also try to allocate resources as efficient as possible in various economic sectors in order to use purposefully-collected resources to achieve sustainable development according to the objectives of the State. (Daei Karim zadeh, 2016). Property and debt management techniques were developed for strategic planning and forecasting income and revenue and modeling based on balance sheets, which represent sources and uses (see e.g. Andelinovic et al., 2020, Kliber et al., 2021, and many other). In 2003, the Society of Insurance Experts defined property and Debt Management as: Asset management and debt management is the constant process of formulating, monitoring and revising strategies related to assets and debts to achieve the organization's financial objectives, taking into account the risk deviation and other constraints of the organization. Property management and debt is regarded as the process of evaluation and control of the company's rows to achieve the financial goals This process includes planning, guiding and controlling the currents, levels, and combinations of funds, as well as the cost of and company's incomes, with the process of controlling financial and nile spheres (Izzyneh et al., 2011). There are a variety of approaches to manage the property and debt, which are then summarized:

- **Along efficient border**: This theory has been used in asset and debt management. Using the Average-Variance Static model for asset allocation, companies select their policy on the effective border and then clone the output of the required allocation policy to study the revenue objectives and the requirements of payment power or reserve (Mehregan et al., 2011).

- **Time harmonic current Duration Matching**: This approach, called the late approach, is an important method for measuring the sensitivity of interest rates of s and debit debts and calls the time to access cash flow, debt and finance, and to calculate that time rhythm, in order to calculate it, the current value of the assets of the provinces and debt divides them (Vaidyanathan, 1999).

- **Cash flow and secure**: This approach includes ensuring that the static adaptation between the light cash flow of assets and the debt commitments made by. Since it is not possible to fully adapt, there is another technique called immunisation, which the risk of interest rate is able to manage the incomplete compliance of property with debts in a dynamic way. The Interest Rate Management (RFR) technique can be extended more than the simple approach of the axis (adapting the current value of the time harmonic) (Amenc et al., 2007).

- **Redundant**: There are two fundamental steps in this method: The first step is to use mathematical models to create probable scenarios for all the risk factors affecting assets and debts (interest rates, inflation, securities prices, real estate, etc.). The second step is to use optimization techniques to find the optimal basket groups. Based on the simulation of probable scenario, there is a distinction between three main types of risks affecting the values of finance and debt (interest rate, inflation and price of securities) (Da Silva et al., 2013).

- **Mathematical program**: At least a half-century has passed since the application of operational research methods in solving the financial. This method plays an important role in adapting new financial theory to financial markets. The main and distinctive feature in financial markets is that they are well-defined and. In these problems, the aim is to

incorporate profit and minimum risk, and the related variables are readable, and the relationship between variables is clear (Kosmidou and Zopounidis, 2004).

Ideal planning is one of the mathematical modeling methods for asset management and debt management and according to its properties, has been considered to be of great interest in modeling and solving financial problems.

The ideal planning is one of the most practical methods of research in operations that was first presented by Charnes and Cooper in 1961. In ErmangP planning), the path to simultaneously move into multiple targets (even conflicting). Although the marcowitz quaortic planning model is the most reliable model for choosing prophylactic bonds, due to computational and technical problems and also lack of investor demands in his model, experts have presented different models for this choice. Rosen and Zenios (2006) divided the debt-finance management strategies in four groups:

Stationary and single time models

In this group, the models are protected against the pre-determined changes resulting from the current status of interest rates such as interest rates. The stock baskets have been created that the investor will be treated in a predictable and acceptable manner (Naqshineh et al., 2013).

One-time probabilistic models

These models describe the distribution of efficiency assets and debts due to random market actions. The possible models the risk clearly and quantitatively, but these models are facing uncertainty at the end of the one-time period (Izadi et al., 2011).

Multi-time static models

A multi-time stagnant environment is where perturbed investors retune over a few periods in an environment that is well-defined or where changes are well-defined in the stimulus factors of the variable model. However, without risk factor, these models have limited application and these models have been replaced by a few-time probable models (Izadi nia et al., 2011).

Multi-time probabilistic models

These models allow both property and debt to be shown randomly in the probability distribution. Investors may change their aggressive combination over the time of investment, and may make decisions contrary to their previous decisions (Izzyneya et al., 2011).

Bank Resources & Uses

In general, the bank's resources mean the same deposits, and the use of the same facility. Banks must have a balanced relationship with the resources to protect the funds that they have provided from the deposits, and to invest in a place where, in addition to obtaining surplus efficiency on the cost of resources, they must be immediately accountable to customers and depositors. According to these interpretations, the banks provide the

necessary resources to allocate credit to individuals by accepting different kinds of deposits (visit, length, etc.). In banking, resource mobilization is of special importance. Attracting resources on liquidity and risk management of bank liquidity, facility lending, and consequently, it has a significant impact on operational revenues. Therefore, banks need to have a clear analysis of the amount of deposits in their as sources and the amount of facilities and applications during the different time (Agarana et al., 2014). In the banks, the main and main part of the cost of the payments is made to deposits, and the main and main income of the bank is through the lending of the facilities. Since deposits have different rates and interest rates. Since deposits have different rates and facilities profit rates are not the same, the combination of different financial resources.and various combinations of financial uses make different profits for the bank. In other words, each complex of sources and uses has a net profit. As an economic enterprise, the bank seeks to select the complex of resources and Masafi that considering numerous constraints of policy, finance and market, the profits are the most and return of uses to respond to the departure of resources at a higher rate (Elhtiari and Alam in Tabriz, 2015).

BAILMENT OF A CAPITAL

The agreement stipulates that each profit will be determined in accordance with the agreement reached between the bank and the beneficiary of the facilities. The sum of the bank's share will be determined by the Monetary and Credit Council, and at the end of the operation, the profits will be divided according to the contract between the bank and the agent. Since the bank has the right to defend the depositors and lawyers, Article 5 compels the bank to carry out the executive instructions that must be examined and investigated as much as needed before the contracts have been concluded and to ensure that the principle of the capital and the expected profits are restored during the bailment period. The Central Bank announces a rate of expected interest for the application of this material only before the granting of facilities, but the profits must be made based on the real profit from the bailment operation. If the result of failure is detrimental, all the harm will be to the owner of the (depository) capital, and bail is to the same thing that he has done and has no interest in. Unfortunately, in the Law of Banking Operations without Usury, there are conditions that although the law is not legal and jurisprudential, it may cause it to gradually deviate from its original path. On the condition that the agent, in the course of marriage, is committed to making the necessary (peace) Act, which, if any losses are achieved, will be able to prepare it for its own property. This condition indicates that the usurless banking system in Iran does not dare to risk if the Code of Action is given to Article 10 and on the basis of the use of cash money (resources) and its return, as well as the implementation of the other operation, it is no longer necessary to add this condition.

REWARD

The bank may be both an agent and a paradox, but it usually plays a role in the Iranian banking system. Since the structure of Iran's banking system is the same old structure and has not changed according to the new circumstances, banks are usually unable to fulfil their obligation to implement the case. Therefore, according to article 4 of the executive order of reward, they have been allowed to make a contract with a contractor (with the consent and approval of the reward) if they are a factor in reward (with the permission and approval of the reward), but first they must do a part of the work (the bank) themselves, and second, supervise the implementation of the work. One of the issues that can distance reward from its content is that banks can transfer the reward to the front by way of lawyers as the agent. According to Nb/15, 68/3, 18/8/18, 65/18, banks have been banned, but unfortunately, it is

observed that despite the ban, some banks do this today and make some of the branches superficial. The journal has a lot of applications in trade, export and import, production it has. Below, to turn the subject on, we only mention and describe one item: One common case is housing repair. According to a contract for someone who needs repair, he goes to the bank and asks the bank to repair his home. The bank will agree on a certain amount of alzhema after reviewing the expenses and the costs of the repair and taking into account the sum of the right. The bank has a duty to repair the house itself or contract a contract to repair the house. No objection shall be made to the Convention if such an action is done. At times, however, it is seen that some branches provide a specific amount of money to the owner of the house, and he is appointed by a lawyerto repair the house in place of a bank. The problem here is that people may come to the bank and get money from the bank in the name of housing repair and spend money elsewhere. They don't own money from the bank,

CIVIL PARTICIPATION

Although in the company, each company can share in any proportion, Article 12 of the Executive Guidelines for Civil participation obligates banks, which can only contribute to 80% of the projects. In civil participation, the minimum expected profit will be determined by the Monetary and Credit Council to evaluate the projects and announced to banks. It is worth mentioning that the above mentioned rate is only for evaluation of the plan and it cannot be considered as a final rate and demanded. For example, banking facilities can be used by civil participation to build housing. In this case, a portion of the necessary capital will be shared in the building, but since the bank is the attorney of the depositors and is obligated to invest their capital in profitable projects, it must be assessed before the company contracts have been concluded by bank experts in order to ensure the project's profitability by the Monetary Council. If the evaluation results are positive, the bank will conclude a civil partnership agreement. After the construction of the bank as a partner, the bank sells its share to its partner, and the partner can purchase the bank's share in cash or in installments, and banks have been allowed to share their share in installments based on Note 2 of Article 10 of the Civil Partnership Executive Guidelines. In civil participation, the banking system has escaped the risk (which is the basis of Islamic banking) but to avoid the confrontation with the jurisprudential and legal forms it expresses: "The condition is against the contract requirements", while accepting the losses incurred by his share, convinced the partner, in addition to a necessary contract (usually a peace deal), to prepare the damages from his own property. This conception of truth leads to concern that the banking system is gradually turning towards superficial.

Portfolio includes a risky asset and a non-risky asset

The non-risk property is an asset with a low-efficiency but no risk return, so the standard deviation of its return is zero and its expected return is equal to its real. In addition, non-risk property does not correspond with risk property (zero correlation) or, in other words, it can be written for all the Riskii assetspi; f = cov(xi , , , , or in other words, for all of the Riskii property xf = 0. If the price of sale is allowed at the unrisk rate, then it means a positive amount of investment in the non-risk property (the non-risk share of the property), and the sale of a deposit means a negative share for the non-risk property (Bakyts, 2004).

A investor in a portfolio has two risk and non-risk assets: w has a risk share in portfolio and (1-w) the share of non-risk property. As a result, the prefolic (Rp) yield is defined as :

$$R_p = w.R_r + (1-w).R_{rf}$$

R_r : Return on risky assets

(1)R_{rf} : Non-risk asset return, ie risk-free rate

The expected return and standard deviation (ie risk) of the investor's portfolio are as follows:

(2)

$$E(R_p) = w.E(R_r) + (1-w).R_{rf} = R_{rf} + w.[E(R_r) - R_{rf}]$$

$$\sigma_p = \sqrt{w^2.\sigma_r^2 + (1-w).\sigma_{rf}^2} = w.\sigma_r \quad (3)$$

As stated in the previous section, there is a relationship between risk and return on a portfolio. To examine this relationship, one must somehow combine the standard deviation and the expected return of a portfolio extracted above. Weight or share (w) should first be written in terms of the standard deviation of the portfolio and risk assets:

$$w = \frac{\sigma_p}{\sigma_r} \quad (4)$$

W can then be substituted in the portfolio expected return equation:

$$E(R_p) = R_{rf} + \frac{\sigma_p}{\sigma_r}.[E(R_r) - R_{rf}] = R_{rf} + \frac{[E(R_r) - R_{rf}]}{\sigma_r}.\sigma_p \quad (5)$$

The above relationship shows the relationship between risk and return of a portfolio with a risky asset and a non-risky asset. Also called the Capital Allocation Line (CAL), this capital allocation line is shown in Figure (1).

E(R$_p$)

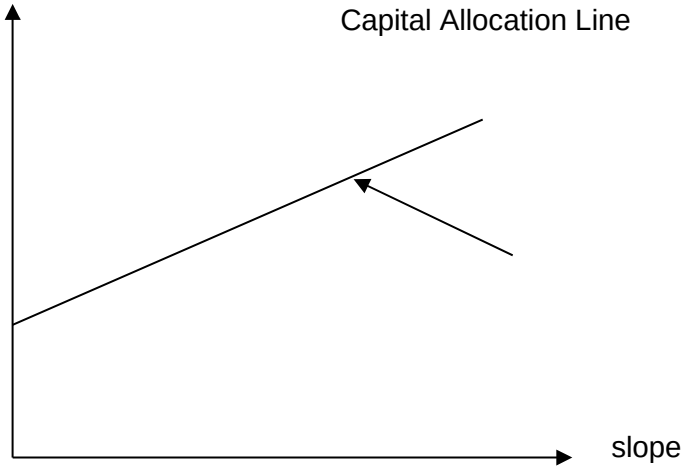


Figure 1. capital allocation line of in the risk-return space (Beckwitz, 2004)

The capital allocation line shows the relationship between risk and return of a portfolio for all possible combinations. In other words, the capital allocation line represents the set of investment opportunities of a risky asset and a non-risky asset. The expression $E(R_r) - R_{rf}$ is the risk surplus value of a risky asset, which is the compensation for accepting the risk surplus

σ_r over a risk-free asset. As a result, the slope coefficient shown below indicates the risk reward:

$$\frac{[E(R_r) - R_{rf}]}{\sigma_r} \qquad (6)$$

In fact, the slope of this scale is "extra return for extra risk." For this reason, it is also called the "Reward to Volatility Ratio" ratio. The total amount of compensation received for accepting the additional amount of risk is equal to:

$$\frac{[E(R_r)-R_{rf}]}{\sigma_r}.\sigma_p \qquad (7)$$

So in general, it that the output of a prefoline is equal to the minimum return (i.e. R_{rf}) plus the risk of additional risk.

So non-risk property like government bonds (like Treasury Bonds) is called non-risk property because a fixed interest rate for the encyclopaements is taken into consideration and is less likely to be paid. The efficiency of non-risk asset has zero variance and therefore it is that there is no correlation between the other assets. As a result, when combined with a risk property or a prefuliu of those assets, change in risk and return will be linear. Since the incorporation of non-risk assets into the portfolio the risk and return linearly, this combination is drawn as a straight line in the risk-efficiency space (chart 1-2). The line starts from a point where non-risk property is weighed in Portuguese 100% and is at a 00% portfolio.

Portfolio includes multiple risk assets

In this section, a Portuguese is paid with a few risk assets with no non-risk property. In this case, the predominant (R_p) yield is defined as:

$$R_p = w_1R_1 + w_2R_2 + \cdots + w_nR_n = \sum w_iR_i \qquad (8)$$

The portfolio's expected return is equal to the total weight of the expected return on all assets:

$$E(R_p) = \sum w_i \times E(R_i) \qquad (9)$$

The standard deviation of a portfolio consisting of two risky assets is determined as follows:

$$\sigma_p = \sqrt{w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2\sigma_1\sigma_2\rho} \qquad (10)$$

$$w_1 + w_2 = 1 \qquad (11)$$

An investor can reduce his risk by increasing the assets in his portfolio. In other words, the investor can reduce portfolio risk by diversifying. Based on the risk equation of a portfolio as

defined above, the effectiveness of portfolio diversification on its return depends on the correlation coefficient (ρ) of the two assets in the portfolio.

Influential components on resource equipping and money allocation in modern banking

- Manpower skills

- Diversity and quality of banking services

Physical factors and conditions

- Location of bank branches

- Design and beauty of interior and exterior of branches

- Physical facilities of bank branches

- Number of branches

Bank deposits

One of the most important factors for survival and survival of organizations such as the Bank to absorb more financial resources, in other words attracting different deposits and optimal use of these resources in the services, trade, industrial and infrastructure of the society. In addition, both bank and customer of the bank, and the country's economic wheels are moving. The banks, by opening different accounts and taking savings, short- and long-term deposits, hold funds as a service for their customers, by using physical labour, pay facilities, direct investment and other banking services. One of the most important tasks is to fund real and legal individuals for investment in various fields and their consumer purchases (Karimi, 2014).

Risk

Numerous definitions of the concept of risk in investment have been made. In a definition, the capital return is called "investment risk" In general, one can say that, the more the output of one asset changes, the more risk the investment. The criteria used to measure the return rate changes is standard deviation. Both variance and standard deviation are criteria of scattering and they are actually connected (Azar et al., 2013).

The standard deviation is calculated as: Azar (Azar 2013):

$$\sigma = \sqrt{\sum_{i=1}^{n} \frac{(X_i - \bar{X})^2}{n-1}} = \sqrt{\sum_{i=1}^{n} (X_i - \bar{X})^2 P_i} \qquad (12)$$

$$\sigma = \sqrt{\sum_{i=1}^{n} (r_i - \bar{r})\, P_i} \qquad (2\text{-}2) \qquad (13)$$

σ = Standard deviation (investment risk index) r_i = Return on assets i

$\bar{r}$= Average rate of return on assets p_i = Probability of assets i

Risk is usually associated with the dispersion of future returns, and dispersion refers to variability. Risk is assumed to increase volatility and dispersion, and this is the difference between the actual return of a currency and its expected return. In fact, if the return of a currency is not scattered and changeable, that currency will be free risk (Azar et al., 2013).

New portfolio theory

In this section, first, the optimal portfolio composition based on risk and non-risk assets is extracted graphically and then this issue will be addressed by algebraic method. The new portfolio theory is also called portfolio management theory. This theory emphasizes that one of the important concepts that investors should be aware of is the relationship between risk and return on financial assets. In other words, as the risk of an asset increases, so does its expected return. This means that if an investor accepts more risk, he expects to be compensated by having a higher return, and if an investor expects a higher return, he should prepare for a higher risk. This section discusses the concept of a new portfolio theory to understand the relationship between risk and the expected return on a portfolio of financial assets. First, the relationship between risk and return of a particular portfolio is discussed. The three types of portfolios that are examined in this section are (Moysey et al., 2012):

1- A portfolio with a risky asset and a risk-free asset.

2- A portfolio with two risky assets.

3- A portfolio with two risky assets and one risk-free asset.

Risky assets and non-risky assets

This classification is based on relative conditions, not absolute, risk property and non-risk. It should be noted that non-financial assets can be completely non-risk. a non-risk property is defined as property, which is the lowest risk level between all available and available-commodities or real estates for example (see Cermakova et al., 2021 or Hromada et al, 2021 for detailed examples of non financial investments). In other words, it is "free risk" than other available. The Treasury bonds, for example, can be considered without risk. Because when the government publishes those bonds due to the tax power, under any circumstances can buy back the bonds that have been published before, the Treasury bonds are considered inexpensive (Goldfarb, 2014). Non-risk property return rates are generally as a risk-free rate. This is an important return for most investors because the rate, which is often used as a basic criteria for other financial. A low risk rate shows the lowest level of efficiency that an investor expects to reach Obviously, an investor will want higher

efficiency when he takes more risk (than a non-risk asset). Return (expected) of a risk property can be as follows (Ding& Sickles, 2018):

$$E(R_r) = R_{rf} + [E(R_r) - R_{rf}] \quad (14)$$

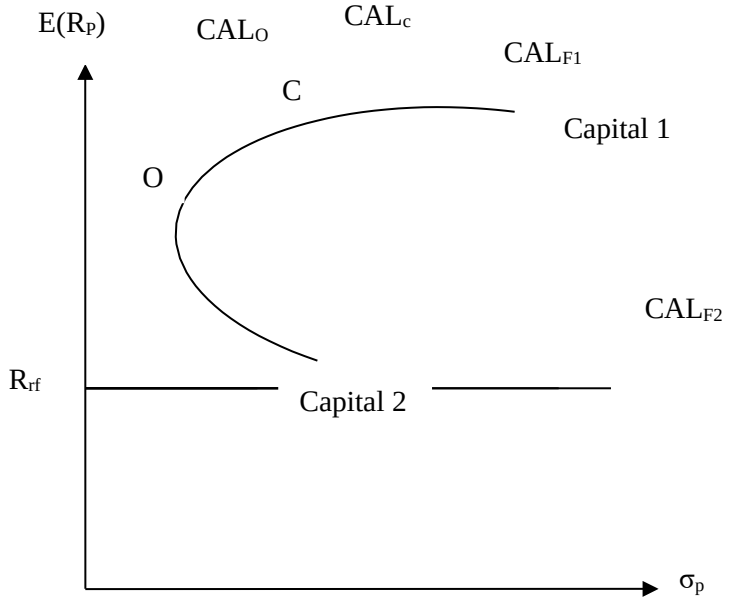
Expected return= a non-risk property (Minimum Compensation) + compensation for additional risk (i.e. additional risk value or Risk Premium) in the above-mentioned relationship, the first part (zero-risk rate) the minimum of the compensations that an investor can expect to receive (or a guaranteed return). The second term measures the difference between the expected return of a risk asset and a non-risk property, which the investor's additional compensation in return

for higher risk. This dispute is known as a risk increase between the expected return of a risk property or the return of a non-risk property (Beckwith, 2004).

Portfolio includes a number of risk and a non-risk asset

An effective Portuguese is the selection of the best property compounds that maximize the expected efficiency according to the given risk value (Markowitz, 1952). This definition is known as the Maxi-Min Criterion an efficient set. In contrast, the "Miny-Max" criteria introduce an efficient set as the best combination of assets that variance for a given yield rate. For simplicity, a Portuguese that includes two risk assets (1 and finance2) and a non-risk property is taken. The investor, depending on what choose the combination of these two assets, at a point along the line CALF2. If the investor only selects the property 1 and non-risk property, then the capital allocation line will be CALF1.

Figure 2. Capital allocation lines, Source: MIC et al. (2012)



According to the above chart, an investor will always choose a prophecy that includes the property of 1 and non-risk assets. Because the CALF1 line is located above the CALF2 line, it means that for a certain level of risk, the investor gets more efficiency from the offspring that includes the property of 1 and non-risk property, compared to the launch of the project, which includes the property of 2 and non-risk assets

Given the same argument, the investor will be in a better position if: He decided to invest in non-risk assets and a certain combination of assets 1 and 2 (Sabadc). Because the CALC line is above the CALF1 Capital Allocation Line. The investor can improve its position by changing the combination of 1 and 2 assets that the capital allocation line to the left. Here, the goal is to achieve the best situation through choosing non-risk assets and a combination of 1 and 2 (prefouliu C) assets. The capital allocation line in this mode is shown as CALO. that the tangent of the border is efficient (on the border of efficiency). The investor cannot move the capital allocation line to the left more than this because it will reach inaccessible locations.

Therefore, profoliu O is an optimal prefolio. In other words, this Portuguese provides the investor with the best exchange between risk and return.

The Fadayi and Ismaili (2016) were considered and prioritizing the factors affecting the financing of financial resources in the Mehr Bank of the Economy of Isfahan province, using the AHP method statistical population of the research is all managers of the Bank of Economic Stamp in Isfahan and 13 of them were selected by purposeful sampling. For data gathering, the questionnaire was used and its validity was confirmed by university and banking experts. Expert Choice11 software (for performing hierarchical analysis) and SPSS 23 (for calculating mean) was used for data analysis. The results showed that the Central Bank's policy criteria have the largest share, and the criteria of Sharia and Legal Restrictions have the least share in decision making. The interest rate of deposits is the

least effective factor in equipping banking resources and quality of services. In "Credit Facility Comment", Abbasian et al. (2016) suggested that the State Financial Regulations regulators provide the necessary legal platforms to limit the development of centralization and increase centralization in the facility and find specialization in one or more sections and a specific industry. Also, the results show that the requirement of internal banks to comply with certain minimum capital adequacy ratios and capital return leads to reduction of bank credit risk. In this paper, Mahmoudian and others (2017) have modeled the good performance of an Islamic bank using the Random Dynamic Optimization Model. In this study, considering the characteristics and characteristics of a desirable pattern in Islamic banking, we have explained the dynamic random model that is appropriate for it. In this way, we can set the optimal path to equip resources at any time of time and its performance. At the end of the paper, the model was and, by changing its parameters, the sensitivity of optimal paths was studied. The results showed that the model of the bank system was sensitive to the different parameters. Bayat and Asadi (2017) have been to optimize the stock portfolio by using the Birds Algorithm and the Markowitz model. In this study, the birds algorithm and the Markowitz model have been used to select the stock basket and a comparison has been done between them. The aim of this study is to introduce a model for selecting investors to choose the right portfolio by evaluating that model.Of the companies listed on Tehran Securities Exchange, 65 companies were selected for the period of 1388- 2013. As a sample size, the data was analyzed. For data analysis, data were collected in EXCEL software and then classified and performed using MATLAB software. The results show that the BIRDS algorithm and Markowitz model have less error in selecting the optimal basket of investment than the Markowitz model. The most important proposal for further research is to compare the Basair Birds Algorithm (PSO) of Optimizing Models such as Colonial Competition, Meta-Heuristics, Arbital Model and Compare. Mubaid Ali al-Jarahi

(2003) described the main features of the Western banking system as a mediator between beneficiaries and beneficiaries of funds (borrowers), payment of short-term loans, and non-interference in borrowers' work. Langvar (2008) has investigated the effect of the value system of customer credit in banks on the bank credits. His results show that some in the banking system do not pay them in any way despite the fact that their loans are due and they are even willing to pay a late fine, but they will use the money. By implementing the credit rating system, these people avoid these activities to re-obtain facilities, and therefore, the money will return quickly to the banking system to be used for crediting other applicants. Therefore, the other advantage is that customers will have more access to more facilities and in the next stages they will try to make repayments on time, because the money will return to the banking system in time. Trabian et al. (2013) evaluated real clients of Sepah Bank with logistics models. In his work, a dependent variable of credibility was considered as a Binary (good and bad). The source noted that financial resources restrictions are one of the main reasons for the challenge of identifying and evaluating the financial ability of customers to pay off the facilities they receive. Age, level of education, gender, facility value and bail value are the most important parameters in the validation work. The results show that age and education are the most important factors affecting customers' values and credit rating. Other variables have a significant relationship with the customer's credit status. Castro (2013) has studied the impact of macroeconomic factors on credit strategy in banking systems. Data collected from 1997 to 2011. In this paper, the relationship between macroeconomic development and banking credit strategy in Greece, Ireland, Portugal, Spain and Italy is investigated by dynamic data method. The results show that credit strategy is significantly affected by macroeconomic factors. Impatience (2014) in a study, examined the impact of macroeconomic risks on credit strategies in Serbia banks. The

results showed that the critical condition of the exchange rate and business cycle caused the banks to lose their lending quality in Serbia. Moreover, statistical evidence shows that the higher EGP index has had a significant effect on the quality of mortgage. Stefanowitz et al. (2014) have to provide the risk model for the Portuguese. They have considered a single-period Forward Stock Optimization (TFPV) model in the uncertainty and in this model, they provide criteria for risk based on the mean-variance (ANOVA) method. Their results showed that mean variance optimization is in accordance with uncertainty in the model and this model can be useful to reduce risk. Karimi (2014) has used logistic regression and artificial neural network to model the credit risk for Iranian commercial banks. This work was done on 316 samples and 5 independent variables. The results of Kramy modeling show that the ANN has a better ability to identify incalculable customers than logistics. Credibility is considered as an binary variable. The results of Karimi modeling have shown that increasing interest rate and repaying delay increases credit risk. The ANN model, in Karimi work, has correctly identified about 93% of the clients with malicious accounts and 63% of the clients with good accounts. This model was used to validate bank customers. In his study, the Binary State-Dependent Variable is considered as good and incalculable. 285 optimistic customers and 214 malicious customers were used to make model. The model is based on tagging study that at least 30 records are required to build a model and for each independent variable, we have 30 to 50 records. In addition, this method should have minimum variables (main variables). The parameters in this model are not absolute and are usually measured relative. In this work, 16 independent variables were considered. Important variables are: age, reimburse debt to the moon, the duration of life in the current place, type of job, amount of credit, other debts. Huang et al. (2015) have used DEA hybrid methods and multi-criteria decision making methods to select the optimal stock. They conducted their research in Taiwan State Company and first ranked companies based on their performance and from them they chose higher performance companies and then to select an optimal stock basket in selected companies using the DEA method. Dincer (2015) has to select an optimal stock basket in the banking sector using AHP and MOORA methods in fuzzy environment. They have carried out their research in Turkish banks in Bursa province, and by evaluating the performance of banks by using AHP and MOORA methods, they have chosen banks with the aim of minimising risk and maximizing profit. Shadkam et al. (2015) in this paper, have investigated the problem of portuguese optimization using fuckoo optimization. They the stock exchange based on the average and return of companies using flocus algorithm to select the optimal basket of the stock exchange, and they have compared the results of this algorithm with genetic algorithm

(GA), which has been shown that the FCSE algorithm has a higher ability to produce quality solutions. Ke et al. (2015) have been diversifying the risk of assets and optimizing the share basket using the genetic algorithm. They used the Marcowitz mean variance model and then used the genetic optimization algorithm to solve this multi-objective model. Feng et al. (2015) have studied the problem of stock basket optimization based on VAR method and have a mixed integer mathematical model, and the model that has been built based on improved steps has been by using an innovative algorithm. Balbas et al. (2015) addressed the issue of allocating capital in risks and ambiguities. Their model is comprehensive in many ways. For example, in their modeling, both discrete and continuous times have been evaluated. The paper includes four important features, in order to include: The model is more efficient and it is also more equitable than the model and it is similar to changing market parameters and using damage factors in the non-definite model. Sharma Vipul (2015) has discussed the issue of evaluating the performance of the launch based on risk based on different evidence in India This study evaluates the performance of risk-based securities in different market conditions. They have evaluated four equally-weighted

(EW), global minimum variance portfolio (GMV), most diversified portfolio (MDP), and Equal risk contribution portfolio (ERC), and their results showed that no single strategy, no other strategies under different market conditions. And the GMV strategy has a minimum risk and there's evidence that the capital-based porteflio usually works better on the market. Bruno and his colleagues (2017) have discussed improperly loans and allocation of resources in European banks during the crisis. The aim of this study was to investigate the relationship between the quality of prefoline and borrowing in European banks in 2005-2014. The results of the approval indicate that there is a negative relationship between poor quality of paramount and borrowing, as a higher NPL ratio explains the reduction in loan growth and loan allocation for public debt (as a percentage of total assets). OH and Patton (2018) have studied the issue of overrisk management. This paper presents a new class of Capula-based dynamic models for large-scale conditional distribution that facilitates a wide assessment of systematic risk measures. The proposed models work on the successful ideas of literature on the modeling of covariance matrices with large dimensions in time variable distribution models. Using the Coopola-based models reduces the estimation of the common model at different stages of the process the computational burden. The Duke et al. (2018) have been working to porteflio, efficiency and risk in different industries of the Association of Southeast Asian Nations (ASEAN) and market index for 10 industries in 2007 to 2016, which includes crisis cycles, after crisis and natural crises. They used the CVAR method to evaluate the risk and determine the weight of different industries in the optimal basket of the shares. Zhou et al. (2019) evaluated the banking system by using a three-step data envelopment analysis method in uncertainty situations. In this paper, for a comprehensive review of the structure. To measure performance over successive periods, this paper developed a multi-stage DEA model in which unused assets were transferred to subsequent periods; fixed assets and employees' salaries were identified as common quotas for all three phases and unpaid loans were identified using triangular fuzzy numbers as undesirable outputs to reflect credit risk. The developed model was used for a case study to evaluate the performance of Chinese commercial banks from 2014 to 2016. The results showed that all these banks are generally inefficient; however, inefficiencies have occurred at different stages for different types of banks.

Methodology

The research method is a set of rules, tools and system methods for investigating the realities, discovering the fields and finding solutions to the problems. A study was carried out to prove the relationship between variables using statistical tests. In humanities different classifications were conducted by the research method. Based on the objective, research method can be fundamental, applied or scientific. The purpose of applied knowledge development is in a specific field and its practical application (Earth, 2004). The present research method is based on the practical objective and the results can be useful for a wide range of managers, shareholders, investors, creditors, researchers and standard formulators. In terms of time, the investigation can be an event or future. Generally, if the data is related to events that occurred in the past, the research plan can be treated as a post-event (Khaki, 2004). This study is conducted by using the post-event approach. The post-event method is used when the researcher examines the topic after the events. In other words, the researcher uses past data to investigate and evaluate hypotheses (Khaki, 2004). Data were collected by using a questionnaire. The data were collected and analyzed by using a descriptive, correlation, experimental, and causal method. A descriptive study of the methods aimed at describing the conditions or phenomena of the investigation. Correlation research includes studies in which the relationship between different variables is identified and explained using correlation coefficient. In correlation research, the main

objective was to determine the type, size and value of the relationship between two or more variables (Sarmad et al., 2011). Descriptive research method is causal. This is because it aims to describe the conditions or phenomena that are studied and to further understand the existing conditions. This study is considered as an applied research in terms of purpose. In this regard, applied research is conducted using existing methods, tools and models in order to improve the current situation or to improve operational productivity.

Base allocation model
Multiparticle algorithm

PSO algorithm is a population-based algorithm which is similar to genetic algorithm (GA-GA). However, the method of search in the solution space by these two algorithms is very different. The similarities of these two algorithms can be mentioned:

1. Both algorithms are based on population. That is, at first, a number of members were produced and

They play around the reply space.

2 Both algorithms use the same function to evaluate the obtained results.

3. Both algorithms have multiple stages before the completion of the algorithm They do.

- FPM proposed

As it has been said, in this study, after selecting the bank using genetic algorithm, the model has been solved using the PSO algorithm. Similarly to Cermakova et al, 2021 who simulates optimum aggregated values of output via behavior algorithm and Vorlicek 2017 confirming that behavior of each entity (bank in our case) produces an equilibrium aggregated results for entire economy, we present in the following text the general structure designed for the PSO method is also discussed.

Step 1:N the initial solvable solution as the population of response is produced.

Step 2: The procedure for improvement applies to the generated responses. Step 3: pg and pi become the initial value.

Step 4: produce an empty set called Pareto archive; Include the K=0 counter. Step 5: Add a unit to the K counter (K=K+1).

Step 6: Update particles.

Step 7: Select the N answer as the next generation answers.

Step 8: Apply the improvement procedure to the selected answers. Step 9: Update pg and pi.

Step 10: Update Pareto Archive.

Step 11: If the K counter has reached its maximum value, go to step 12, otherwise go to step 5.

Step 12: Report Pareto Archive as output and end.

- Improvement procedure

After generating new answers, an improvement procedure is applied to each answer and the answers are improved as much as possible. Here, to improve the answers, three neighborhood search structures are used as variable neighborhood search (VNS). Neighborhood search structures are described individually and their combination as VNS is described below.

First Neighborhood Search Structure:

In this structure, two indices i1 and i2 are in the uniform range [1..n] (n number of assets), the index t is randomly in the uniform range [1..T] and finally the index s is in the uniform range [1..S] (S number of scenarios) is generated. The amounts purchased from assets i1 and i2 are then exchanged for period t and scenario s.

Second neighborhood search structure:

In this structure, two indices i1 and i2 are in the uniform range [1..n] (n number of assets), the index t is randomly in the uniform range [1..T] and finally the index s is in the uniform range [1..S] (S number of scenarios) is generated. Then the amounts sold from assets i1 and i2 in period t and scenario s are exchanged.

Third Neighborhood Search Structure:

In this structure, two indices i1 and i2 are produced in a uniform interval [1..n] (n number of votes) and an index s are produced in a uniform interval [1..S] (S number of scenarios). The amounts purchased and sold from assets i1 and i2 are then exchanged for each period and scenario s.

At the end of each of the described operators, the monetary value of the asset and other variables are calculated or modified according to the model constraints.

These three structures are combined as VNS. The proposed VNS structure is as follows:

The pseudo-code of our VNS is as follows

{for each input solution
K=1

While stopping criterion is meet
do New particle=Apply NSS type
k

If *new solution is better than*
then K=1

Else
K=k+1

If k=4
then K=1

Endif
Endif
Endwhil
e

}

Each of the answers in the population is given to the procedure above and the output answer is added to the population as an improved answer.

As can be seen in the structure above, after applying the neighborhood structure to the response, the acceptance procedure is applied to the resulting response and the previous response, and one of the two responses is selected as the next VNS iteration response. The acceptance procedure works in such a way that it determines and selects the dominant answer from two answers, using non-dominated relations.

To better understand the nature of these relationships, the following key definitions are provided. In all definitions, the following minimization model is considered with p as the decision variable and q as the objective function.

$$\min \quad y = f(x) = (f_1(x), f_2(x), \ldots, f_q(x))' \qquad (15)$$
$$x \in R^p; \quad y \in R^q;$$

Domination Relation

In x_1 multi-criteria optimization problems, the vector overcomes x_2 vector if the following

two conditions are met:

$$f_i(x_1) \le f_i(x_2); \quad i = 1,2,...,q \tag{17}$$

$$f_i(x_1) < f_i(x_2); \quad \exists i \in \{1,2,...,q\}$$

Therefore, the main goal in such issues is to find a set of points that dominate other points.

- Particle update

Here, genetic algorithm operators are used to update the particles. The particle update method is as follows (particle is the answer):

$$x_i^{t+1} = (x_i^t - p_i^t) + (x_i^t - p_g^t) + \overline{x_i^t} \tag{18}$$

In which,

x_i^{t+1}: Part *i* in repetition (generation) *t+1-th*

x_i^t: Part *i* in the repetition of *t*.

p_i^t: The best answer that particle *i* has ever reached (up to this generation).

p_g^t: The best answer ever found.

$\overline{x_i^t}$: A neighborhood of x_i^t generated by the mutation operator.

'-': this is crossover

'+': this is selection

In fact, to obtain the *i-th* answer in the iteration of *t+1-th*, the answer is generated: two are x_i^t and p_i^t results of the intersection operator x_i^t and p_g^t , two are the results of the intersection operator on the jump operator on. Finally, from these and one is the result of the actions of x_i^t 5 answers, the one that has a higher quality and dispersion is selected as x_i^{t+1}. In fact, it is used in this formula as p_g^t and p_i^t guide to reach the next iterative answers.

Tab operator (mutation): The operator of the mutation is derived parallel to the combination of the three search structures explained in the previous part. The parallel structure is as:

Each of the neighboring search structures is applied simultaneously or parallel to the input response. Then, the best solution is chosen from the input results and three outputs of the neighboring search structures are and as the output of the mutation operator is. It should be noted that the best solution with higher quality is based on NON-DOMINATED relations.

Intersection operator:

In this work the single point intersection operator is used that is applied to the v_it^s and

u_it^s variables, so the t-index is produced in the uniform [1.T] and the S index in the uniform [1.S] range, and then for all assets:

Child 1: The values of 1 to T and 1 to S of the first parent are taken from the first parent and the values of the second parent T+1 to T and S+1 to S are received from the second parent.

Child 2: The values of 1 to T and 1 to S of the second parent are taken from the second parent, and the values of the T+1 and S+1 and S+1 to S are handed over to the first parent.

Finally, the values of other variables are calculated and reviewed based on the new values of v_{it}^{s} and u_{it}^{s} variables for both children, considering the limitations of the model and.

3.7.1.5. Updating p_i^t and p_g^t

For each i-th particle, among the neighborhoods found for this answer, if there is a better neighbor than pI, pi is replaced by it, otherwise it remains unchanged.

Of all the answers found so far, if the best answer is better than pg, pg is replaced, otherwise it remains unchanged.

-Pareto Archive Update

As previously mentioned, the solution method used in this paper is based on the Pareto archive. In the proposed algorithm, a set called the Pareto Archive is considered to hold non-subversive (non-dominated) responses produced by the algorithm This set will be updated in each recurrence of the algorithm. The manner of update is that the responses produced in the Pareto archive are replicated and in a pool of responses, and then, through these responses, the answers are selected either at the first level or the same non-conquered answers and are considered as the new Pareto archive. The way of the rating is described in the next section.

- Select the next generation's answers

In each repetition, the algorithm requires a population of responses. In this study, in order to select the next recurrence population, the answers in the population of the replica and the new responses produced by the algorithm have been written in the response pool. After the evaluation of the congestion criteria for each response, using the B-2002 rule, which has the highest quality and the highest dispersion, are selected as the next population. NON-DOMINATED relations are used to sort and level answers. At first all, all answers were compared using NON-DOMINATED relations and then, the results were considered as the first level answers. Then, this method was repeated for the non-commissioned solutions and then the subsequent levels of these solutions are determined. The lower the level number of a response, the higher the. Therefore, in order to select the results, first surface with lower number was. If there is a possibility for selection between the two solutions at the same level, the congestion distance criteria will be. The higher the value of this criterion for the answers on one level, the priority of that answer is to select higher.

- **Genetic algorithm**

Genetic algorithm is a specific kind of evolutionary algorithms that uses meta-physiological techniques such as inheritance and mutation. This algorithm was first introduced in the twentieth century. This algorithm is a population-based meta-heuristic algorithm that works with a population of the solutions in each repetition every solution in the population is called in this chromosome algorithm. This algorithm starts with a population of responses and with the use of mutation operators, the intersection and regeneration. Each of the parts of this algorithm is briefly described.

Initial population generation:

As mentioned, genetic algorithm is a population-based algorithm. In fact, in every repetition or generation, this algorithm works with a population of answers. The size of the population

must be the same on all the iterations in the algorithm. At the beginning of the operation, a population of initial solutions with a parameter in the algorithm must be produced.

Tab:

In each iteration of the algorithm, one percentage of the solutions is selected and a neighborhood search operator is applied on these responses and it is called a mutation operator The number of solutions selected to apply this operator depends on the tab rate. The rate of jump is 0-1 and the input parameter is the algorithm. For example, if the mutation rate is 0.2, 20% of the responses in population will be selected to apply the mutation operator.

Intersection:

Another operator of the genetic algorithm is the intersection operator, which is applied to two selected answers or two parents and produces two children. The number of answers selected for the intersection operator depends on the intersection rate. The intersection rate of a number is between 0 and 1 and is one of the input parameters of the algorithm. If the intersection rate is 0.6, 60% of the responses in the population on which no operator has ever been applied are selected to apply the intersection operator.

Renewal:

A number of responses in the population on which the two mutation and intersection operators have not been applied will be passed on to the next generation without any changes. The number of these responses also depends on the regeneration rate.

It should be noted that the sum of the rates of the three operators of the genetic algorithm must be equal to 1.

Parent selection:

As mentioned in the description of the intersection operator, two answers are selected as parents to execute this operator and are given to this operator. There are several ways to select a parent.

Fit function:

This function is calculated for each of the answers and is a criterion for comparing the answers.

- The proposed structure of the genetic algorithm

In this research, in order to solve the model, a genetic algorithm is used, which is designed as a combination. In the combined structure of this algorithm, the main structure of the algorithm is combined with an improvement procedure based on the variable neighborhood search structure (VNS). The pseudo-code of the hybrid genetic algorithm is as follows:

{

Step 1: Generate the answerable N as the initial answers of the algorithm.
Step 2: Determine the jump and intersection rates; Define the counter K =
0. Step 3: Apply the improvement procedure to the initial N answers.

Step 4: Add a unit to the K counter (K = K + 1)

Step 5: Depending on the intersection rate, select the parents from the set of answers and apply the intersection operator.

Step 6: According to the jump rate, select the answers from the set of answers and apply the jump operator.

Step 7: N The answer with higher quality and dispersion should be selected from the next generation answers.

Step 8: Apply the improvement procedure to the selected answers.

Step 9: If the K counter has reached its maximum value, go to step 10, otherwise go to step 4. Step 10: Report unsuccessful answers as output and end.

}- How to display the answer and generate the initial answers

In the genetic algorithm, the answer is displayed and the initial answers are generated, such as the particle mass algorithm.

- Improvement procedure

In this dissertation, an improvement procedure is designed that is applied to the answers (chromosomes) and improves those answers as much as possible. The improvement procedure designed in this thesis is based on variable neighborhood search (VNS).

The structure of the genetic algorithm improvement procedure is similar to that of a particle mass algorithm.

- Genetic algorithm operators

Mutation operator:

In each iteration of the genetic algorithm, a mutation operator is applied to a group of chromosomes. The mutation operator used in this paper is the same as variable neighborhood search (VNS), which is fully described in the previous section.

Intersection operator:

The intersection operator designed in this algorithm is a single point intersection operator. After two parents are crossed as input to the operator, two children are generated as two new answers.

In the children (new answers) generated, the model constraints are checked and if the constraints are not met, the corresponding values are corrected.

It should also be noted that the roulette wheel method has been used to select parents.
Renewal operator:

This operator transmits all the answers to which the mutation and intersection operator has not been applied to the next generation.

- Select the next generation answers

As mentioned, genetic algorithm is based on population and works with N in each repetition of the algorithm. In each recurrence, N, which has the highest quality and dispersion, is selected and transferred to the next generation.

In this paper, a model has been proposed based on the minimization of risk and SPP-CVAR method. To estimate the SPP-CVAR values, there are different methods that in this study, historical simulation method was used. SPP-CVAR estimation model is only useful when they can estimate the risk accurately. For this reason, the performance of these models should be evaluated and evaluated.

Table 1. Sample Members list:

No.	Branch name	Branch nam	Branch nam
1	Arak	**20**	Shiraz
2	Ardabil	**21**	Qazvin
3	Urmia	**22**	Qom
4	Esfahan	**23**	Kashan
5	Ahwaz	**24**	Karaj

6	Ilam	**25**	Kerman
7	Bojnord	**26**	Kermanshah
8	Bandar Abbas	**27**	Mashhad
9	Bushehr	**28**	Hamedan
10	Birjand	**29**	Yasouj
11	Tabriz	**30**	Yazd
12	Khorramabad	**31**	Gorgan
13	Rasht	**32**	Argentina Branch
14	Zahedan	**33**	Keshavarz Boulevard
15	Zanjan	**34**	Tajrish
16	Sari	**45**	Central Branch
17	Semnan	**36**	Mirdamad
18	Sanandaj	**37**	Kish
19	Shahr e Kord	**38**	Chabahar

After determining the list of bank branches, using particle mass algorithm and genetics, the model is solved and the optimal pattern of financial resource allocation is explained. Population size parameters, number of repetitions of variable neighborhood search and number of replication algorithms in particle mass method and parameters of population size, jump rate and intersection rate and number of replication algorithms in genetic algorithm are among these parameters. To set the parameters of the algorithms, the values of each of these parameters are examined in three levels.

Stable planning model of bank resource allocation

A) Indices and model parameters

N: number of assets and i asset index

T: number of courses studied and t course
index S: Number of scenarios and sen
Scenario Index

$prob_{sen}$: Probability of occurrence of sen scenario

r_{it}^{sen}: The return on the i asset in period t under the sen scenario where this parameter represents the components of the Y vector in SPP-CVAR calculations.

c_{buy}: Transaction costs arising from the purchase of assets at the beginning of the period.

c_{sell}: Transaction costs arising from the sale of assets at the beginning of the portfolio period.

r_l: lending rate

r_b: borrowing rate

W0: The initial wealth of the bank at the beginning of the period

A: Confidence level

B) Model variable

x_{it}^{sen}: The monetary value of asset i is initially period t under the sen scenario

v_{it}^{sen}: The amount purchased from asset i at the beginning of period t under the sen scenario

u_{it}^{sen}: The amount of asset sales i at the beginning of period t under the sen scenario

b_t^{sen}: The amount of money borrowed at the beginning of period t under the sen scenario

w_t^{sen}: Bank wealth at period t under the sen scenario

Weightt: Optimal weight for period t

C) Matematical model

The objective function is based on the SPP-CVAR model and minimization of Fb(X,a,sen) is considered for each sen scenario.

$$\min z_1 = \sum_{sen=1}^{S} prob_{sen} \sum_{t=1}^{T} weight_t F_\beta(X, \alpha, sen) \quad (19)$$

$$\text{MAX } z_2 = \sum_{sen=1}^{S} prob_{sen} w_T^{sen} \quad (20)$$

The first objective function is to minimize risk (Equation 19) and the second objective function is to maximize the bank's wealth at the beginning of the final planning period (Equation 20.)

Consraints:

$$\sum_{i=1}^{N} (1 + c_{buy}) v_{i.}^{sen} + x_{..}^{sen} = w_. + b_.^{sen} \qquad \forall sen \quad (21)$$

(22)

Constraints (21) is the constraint of budget in zero time and states that the total initial investmetns of the bank should eb equal to initial welth or budject.

$$x_{it}^{sen} = \left(1 + r_{i,t-1}^{sen}\right)\left(x_{i,t-1}^{sen} - u_{i,t-1}^{sen} + v_{i,t-1}^{sen}\right) \quad \forall sen \quad (23)$$

$$x_{.,1}^{sen} = (1 + r_l)\left(x_{.,.}^{sen}\right) - b_1^{sen} \quad \forall sen \quad (24)$$

$$x_{\cdot,t}^{sen} = (1 + r_l)\left(x_{\cdot,t-1}^{sen} + \sum_{i=1}^{N}(1 + c_{sell})u_{i,t-1}^{sen} - \sum_{i=1}^{N}(1 + c_{buy})v_{i,t-1}^{sen}\right) - b_{t-1}^{sen} \times (1 + r_b) + b_t^{sen} \quad \forall sen, t = 2,3, \dots, T-1 \tag{25}$$

$$x_{\cdot,T}^{sen} = (1 + r_l)\left(x_{\cdot,T-1}^{sen} + \sum_{i=1}^{N}(1 + c_{sell})u_{i,T-1}^{sen} - \sum_{i=1}^{N}(1 + c_{buy})v_{i,T-1}^{sen}\right) - b_{T-1}^{sen} \times (1 + r_b) \quad \forall sen \tag{26}$$

Constraint (24) shows the cash flow in t period.

$$\sum_{i=0}^{N} x_{it}^{sen} = w_t^{sen} \quad \forall sen, t = 1,2, \dots, T-1 \tag{27}$$

Constraint (26) calculates the accumulated wealth at the end of the t-th period under the sen scenario.

$$weight_t = \begin{cases} \gamma(w_{t-1}^{sen} - \tau)^{\varphi} & w_{t-1}^{sen} \geq \tau \\ -\gamma(w_{t-1}^{sen} - \tau)^{\varphi 1} & w_{t-1}^{sen} \leq \tau \end{cases} \tag{28}$$

The (27) limit the bank's utility. invariant1, invariant, γ and are the parameters that are asked for the bank and calculate the weight of each period by the following function and by the value of the wealth obtained from the previous period. Using this relationship, at first the bank identifies some wealth as standard wealth in the form of π parameter. Then in each period, the bank's interest in planning will change to the size that is lower than or higher than the standard value.

As mentioned at the beginning, in this paper, we are looking to provide a robust optimization model, then based on the developed mathematical model, we.

Suppose zsen is the target function value for the sen scenario.

In this research, Malawi Wired model was used to plan , and according to this method, the optimal planning model will be as follows:

$$\min z_1 = \sum_{sen=1}^{S} prob_{sen} \sum_{t=1}^{T} weight_t F_\beta(X, \alpha, sen) + \delta \sum_{sen=1}^{S} prob_{sen}(\emptyset_{sen}^{+} + \emptyset_{sen}^{-}) \quad (29)$$

$$\text{MAX } z_2 = \sum_{sen=1}^{S} prob_{sen} w_T^{sen} + \delta \sum_{sen=1}^{S} prob_{sen}(\emptyset_{sen}^{+} + \emptyset_{sen}^{-}) \quad (30)$$

Constraints محدودیتها:

$$\sum_{i=1}^{N} (1 + c_{buy}) v_{i.}^{sen} + x_{..}^{sen} = w_. + b_.^{sen} \qquad \forall sen \quad (31)$$

$$x_{it}^{sen} = (1 + r_{i,t-1}^{sen})(x_{i,t-1}^{sen} - u_{i,t-1}^{sen} + v_{i,t-1}^{sen}) \quad \forall sen$$
$$x_{.,1}^{sen} = (1 + r_l)(x_{.,.}^{sen}) - b_1^{sen} \quad \forall sen \quad (32)$$

$$x_{.,t}^{sen} = (1 + r_l)\left(x_{.,t-1}^{sen} + \sum_{i=1}^{N} (1 + c_{sell}) u_{i,t-1}^{sen} - \sum_{i=1}^{N} (1 + c_{buy}) v_{i,t-1}^{sen}\right) - b_{t-1}^{sen} \times (1 + r_b) + b_t^{sen} \quad \forall sen, t = 2,3, \dots, T - 1 \quad (33)$$

$$x_{.,T}^{sen} = (1 + r_l)\left(x_{.,T-1}^{sen} + \sum_{i=1}^{N} (1 + c_{sell}) u_{i,T-1}^{sen} - \sum_{i=1}^{N} (1 + c_{buy}) v_{i,T-1}^{sen}\right) - b_{T-1}^{sen} \times (1 + r_b) \quad \forall sen \quad (34)$$

$$\sum_{i=0}^{N} x_{it}^{sen} = w_t^{sen} \; \forall sen, t = 1,2, \ldots, T-1 \qquad (35)$$

$$weight_t = \begin{cases} \gamma(w_{t-1}^{sen} - \tau)^{\varphi} & w_{t-1}^{sen} \geq \tau \\ -\gamma(w_{t-1}^{sen} - \tau)^{\varphi'} & w_{t-1}^{sen} \leq \tau \end{cases} \qquad (36)$$

$$\sum_{t=1}^{T} weight_t F_\beta(X, \alpha, sen) - prob_{sen} \sum_{t=1}^{T} weight_t F_\beta(X, \alpha, sen) = \emptyset_{sen}^{+} + \emptyset_{sen}^{-} \; \forall sen \qquad (37)$$

$$w_T^{sen} - prob_{sen} w_T^{sen} = \emptyset_{sen}^{+} + \emptyset_{sen}^{-} \; \forall sen \qquad (38)$$

GAP (relative deviation percentage) is used for analysis. The method of its calculation is

$$GAP = \left(\frac{a\lg_{sol} - best_{sol}}{best_{sol}}\right) \times 100$$

shown below:

alg_{sol} : The value of the objective function obtained by combining the desired parameters.

$best_{sol}$: The best value of the objective function obtained from the execution of the algorithm.

In fact, the problem is executed for each of the mentioned combinations in the relevant tables and the GAP criterion for each algorithm is calculated and finally the corresponding diagram is drawn.

The cost of sales for the years under review is shown in Table (2).

Table 2. The cost of buying and selling assets

Cost type		2018	2017	2016	2015	2014
c_{buy} :Transaction costs arising from the purchase of assets	cost	123	47	15	7	10
c_{sell} :Transaction costs arising from the sale of assets	wage	824	1,056	737	1,826	706

The lending rate is 0.18 and the lending rate is 0.12.

As mentioned, particle mass and genetic algorithms were used to solve the model. These algorithms were implemented separately for the SPP-CVAR risk estimation function for confidence levels of 0.9, 0.95 and 0.99.

Table 3. Model solution results

Reliability level / time and value of the algorithm objective function			$\alpha = 0.9$	$\alpha = 0.95$	$\alpha = 0.99$
Objective functions The first objective (SPP-CVAR risk	Particle Swarm Algorithm	Time	1.056	1.055	1.103
		First objective	5.655	5.113	3.475
		Second objective	102387	102031	100694
	Genetic algorithm	Time	1.112	1.112	1.198

estimation and the second goal)		**First objective**	**6.722**	**6.402**	**4.869**
		Second objective	**84055**	**85631**	**84059**

As observed in table (3), in all levels of confidence and the optimal risk values, based on the estimation of SPP-CVAR method by the particle size algorithm, the PGA algorithm is lower than genetic algorithm, which indicates the PSO performance better than genetic algorithm. Also, the optimum wealth obtained from PSA is higher at all levels of confidence than the corresponding value of genetic algorithm (GA), and this is another reason to confirm the performance of PSO algorithm compared to the genetic algorithm (GA).

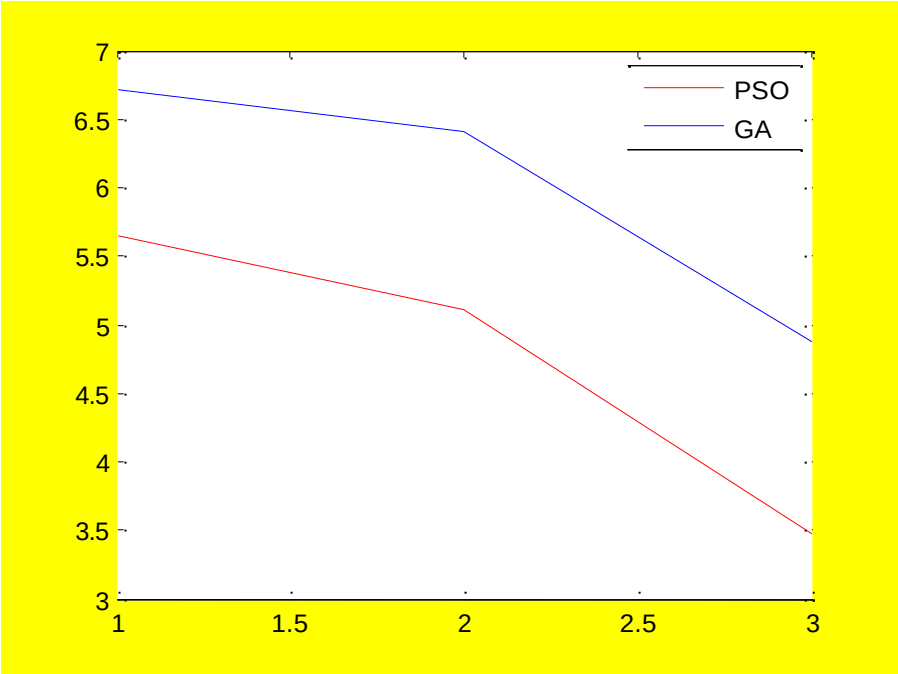
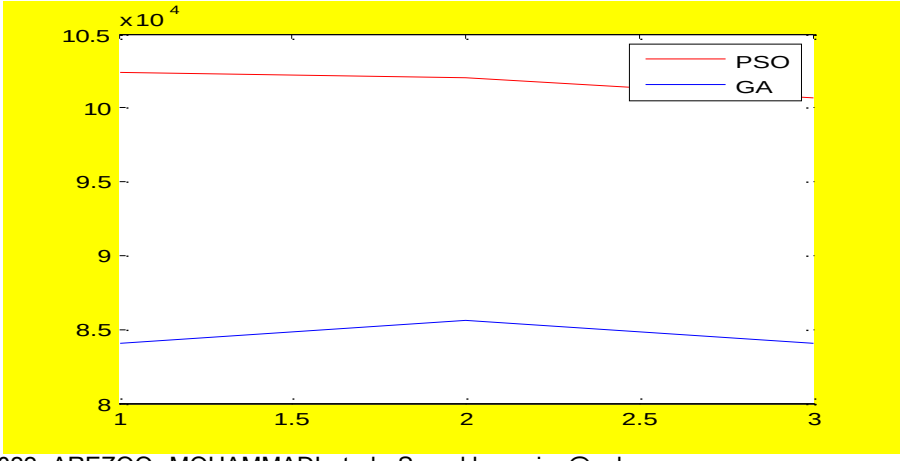


Figure 2. Comparison of the value of the first objective function of the two solving algorithms based on the value of SPP-CVAR

As shown in Figure 2, the values of the first objective function obtained from the particle mass algorithm for all confidence levels are less than the corresponding values obtained



from the genetic algorithm.

Figure 3. Comparison of the value of the first objective function of the two solution algorithms based on the value of the second objective function (final wealth of the bank)

As shown in Figure (3), the optimal answer obtained from the PSO algorithm in relation to the second objective function is better than the corresponding value obtained from the genetic algorithm. In other words, the optimal ultimate wealth of the particle mass algorithm is greater than the genetic algorithm.

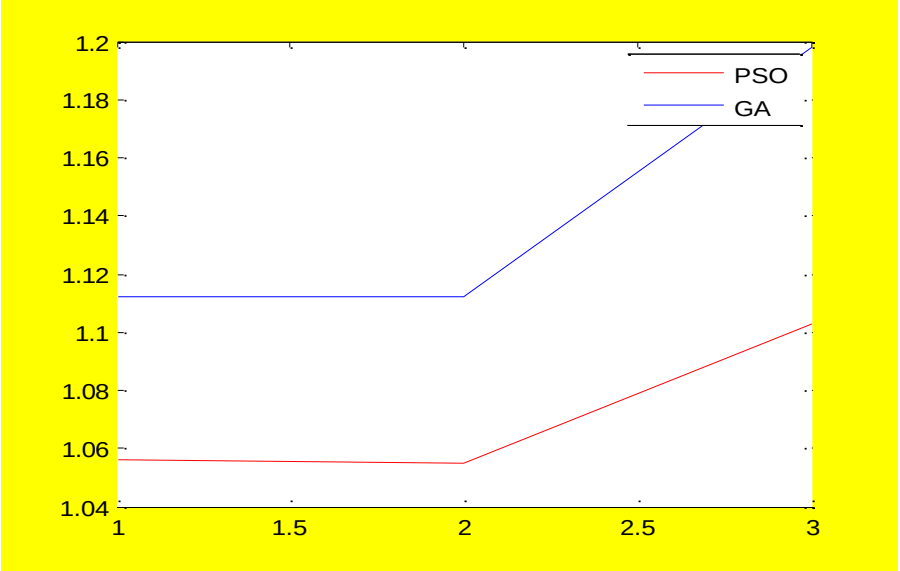


Figure 4. Comparison of execution time of two algorithms

Also, a comparison of the execution times of the algorithms in Table (3) and Figure (4) shows that the particle mass algorithm time for the confidence level of 0.9, 0.95 and 0.99 is less than the execution time of the genetic algorithm.

Tables (1-4) to (4-10) also show the optimal amount of buying and selling assets in each scenario.

Table 4. A - Amount of purchases (receivables from banks and government - accounts receivable - receivables from subsidiaries - tangible and intangible fixed assets and other assets) under scenario 1

Assets / Year	**2014**	**2015**	**2016**	**2017**	**2018**
industry and Mining	**74**	**32**	**80**	**75**	**37**
Agriculture	**69**	**97**	**42**	**23**	**63**

Chemical and petrochemical	**35**	**30**	**97**	**20**	**44**
Technical and engineering services	**96**	**47**	**88**	**93**	**14**

Table 5. Sales amount (facilities) under scenario 1

Assets / Year	**2014**	**2015**	**2016**	**2017**	**2018**
industry and Mining	**30**	**31**	**70**	**94**	**95**
Agriculture	**31**	**60**	**76**	**19**	**71**
Chemical and petrochemical	**83**	**58**	**68**	**1**	**12**
Technical and engineering services	**56**	**15**	**96**	**98**	**15**

Table 5. Purchase amount under scenario 2

Assets / Year	**2014**	**2015**	**2016**	**2017**	**2018**
industry and Mining	**36**	**57**	**64**	**55**	**65**
Agriculture	**16**	**30**	**67**	**75**	**15**
Chemical and petrochemical	**30**	**39**	**72**	**54**	**13**
Technical and engineering services	**85**	**43**	**44**	**23**	**10**

Table 6. Sales amount under scenario 2

Assets / Year	**2014**	**2015**	**2016**	**2017**	**2018**
industry and Mining	**86**	**100**	**69**	**44**	**78**

Agriculture	**33**	**65**	**8**	**99**	**32**
Chemical and petrochemical	**93**	**82**	**23**	**33**	**75**
Technical and engineering services	**10**	**51**	**71**	**93**	**39**

Table 7. Amount of assets purchased under scenario 3

Assets / Year	**2014**	**2015**	**2016**	**2017**	**2018**
industry and Mining	**45**	**43**	**43**	**27**	**32**
Agriculture	**17**	**60**	**62**	**61**	**32**
Chemical and petrochemical	**50**	**7**	**47**	**35**	**33**
Technical and engineering services	**57**	**89**	**96**	**19**	**38**

Table 8. Sales amount under scenario 3

Assets / Year	**2014**	**2015**	**2016**	**2017**	**2018**
industry and Mining	**15**	**7**	**43**	**42**	**46**
Agriculture	**14**	**68**	**93**	**38**	**74**
Chemical and petrochemical	**44**	**87**	**10**	**95**	**89**
Technical and engineering services	**10**	**36**	**31**	**37**	**31**

Table 9. The amount of purchases under scenario 4

Assets / Year	2014	2015	2016	2017	2018
industry and Mining	74	96	18	22	19
Agriculture	73	9	2	89	2
Chemical and petrochemical	84	22	81	23	21
Technical and engineering services	26	79	16	25	1

Table 10. Sales amount under scenario 4

Assets / Year	2014	2015	2016	2017	2018
industry and Mining	97	11	71	93	73
Agriculture	39	65	94	89	19
Chemical and petrochemical	15	67	45	60	90
Technical and engineering services	96	97	99	97	56

Table 11. Purchase amount under scenario 5

Assets / Year	2014	2015	2016	2017	2018
industry and Mining	29	48	15	35	46
Agriculture	41	53	14	35	54

Chemical and petrochemical	**42**	**41**	**68**	**99**	**8**
Technical and engineering services	**9**	**81**	**55**	**70**	**16**

Table 12. Sales amount under scenario 5

Assets / Year	**2014**	**2015**	**2016**	**2017**	**2018**
industry and Mining	**49**	**58**	**61**	**60**	**40**
Agriculture	**55**	**48**	**99**	**79**	**43**
Chemical and petrochemical	**79**	**30**	**94**	**67**	**86**
Technical and engineering services	**66**	**59**	**42**	**53**	**31**

Table 13. The amount of purchases under scenario 6

Assets / Year	**2014**	**2015**	**2016**	**2017**	**2018**
industry and Mining	**66**	**36**	**27**	**88**	**70**
Agriculture	**100**	**36**	**64**	**57**	**68**
Chemical and petrochemical	**73**	**21**	**81**	**70**	**2**
Technical and engineering services	**62**	**96**	**99**	**39**	**79**

Table 14. Sales amount under scenario 6

Assets / Year	2014	2015	2016	2017	2018
industry and Mining	**30**	**42**	**73**	**52**	**35**
Agriculture	**25**	**96**	**13**	**87**	**75**
Chemical and petrochemical	**35**	**29**	**26**	**80**	**4**
Technical and engineering services	**96**	**97**	**65**	**85**	**22**

Table 15. The amount of purchases under scenario 7

Assets / Year	2014	2015	2016	2017	2018
industry and Mining	**56**	**29**	**14**	**58**	**98**
Agriculture	**95**	**80**	**53**	**87**	**39**
Chemical and petrochemical	**22**	**74**	**78**	**35**	**53**
Technical and engineering services	**16**	**2**	**84**	**68**	**31**

Table 14. Sales amount under scenario 7

Assets / Year	2014	2015	2016	2017	2018
industry and Mining	42	27	63	35	85
Agriculture	74	36	19	99	40
Chemical and petrochemical	75	96	60	72	30
Technical and engineering services	12	1	25	16	66

Table 15. Purchase amount under scenario 8

Assets / Year	2014	2015	2016	2017	2018
industry and Mining	28	45	34	7	43
Agriculture	2	3	32	92	71
Chemical and petrochemical	65	82	27	49	14
Technical and engineering services	32	54	42	14	52

Table 16. Sales amount under scenario 8

Assets / Year	2014	2015	2016	2017	2018
industry and Mining	5	13	41	58	33
Agriculture	91	43	20	37	39
Chemical and petrochemical	92	60	25	71	4

Technical and engineering services	**7**	**59**	**20**	**95**	**8**

Table 17. The amount of purchases under scenario 9

Assets / Year	**2014**	**2015**	**2016**	**2017**	**2018**
industry and Mining	**21**	**57**	**24**	**86**	**29**
Agriculture	**92**	**71**	**95**	**47**	**40**
Chemical and petrochemical	**34**	**49**	**22**	**58**	**20**
Technical and engineering services	**90**	**1**	**68**	**71**	**50**

Table 18. Sales amount under scenario 9

Assets / Year	**2014**		**2015**	**2016**	**2017**	**2018**
industry and Mining	**48**		**3**	**16**	**23**	**57**
Agriculture	**17**		**79**	**40**	**82**	**65**
Chemical and petrochemical	**70**		**98**	**78**	**84**	**43**
Technical and engineering services	**98**		**65**	**63**	**14**	**98**

Table 19. The amount of purchases under scenario 10

Assets / Year	2014	2015	2016	2017	2018
industry and Mining	80	63	34	94	45
Agriculture	94	36	2	89	61
Chemical and petrochemical	52	33	29	19	58
Technical and engineering services	4	27	69	35	53

Table 20. Sales amount under scenario 10

Assets / Year	2014	2015	2016	2017	2018
industry and Mining	90	3	41	19	2
Agriculture	94	51	80	95	8
Chemical and petrochemical	89	27	81	67	86
Technical and engineering services	10	24	26	99	12

Bental and Marguerite (2000) solidly modeled the problem of multi-period stock selection. Satisfies what uncertain market prices will accept in the future.

Table 21. Purchase amount (receivables from banks and government - accounts receivable - receivables from subsidiaries - tangible and intangible fixed assets and other assets) under scenario 1

Assets / Year	2014	2015	2016	2017	2018
industry and Mining	74	32	80	75	37

Agriculture	**69**	**97**	**42**	**23**	**63**
Chemical and petrochemical	**35**	**30**	**97**	**20**	**44**
Technical and engineering services	**96**	**47**	**88**	**93**	**14**

Table 22. Sales amount (facilities) under scenario 1

Assets / Year	**2014**	**2015**	**2016**	**2017**	**2018**
industry and Mining	**30**	**31**	**70**	**94**	**95**
Agriculture	**31**	**60**	**76**	**19**	**71**
Chemical and petrochemical	**83**	**58**	**68**	**1**	**12**
Technical and engineering services	**56**	**15**	**96**	**98**	**15**

Table 23. shows the amount of wealth in each period and each scenario.

Year/scen ario	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
2014	**106457**	**106415**	**107300**	**104114**	**108517**	**105637**	**106723**	**107562**	**100086**	**108840**
2015	**104120**	**100522**	**103719**	**106385**	**100297**	**101436**	**104766**	**101183**	**99561**	**104661**
2016	**102864**	**100675**	**105104**	**100440**	**108439**	**102883**	**105100**	**105324**	**105053**	**104002**
2017	**108669**	**99646**	**101838**	**103146**	**100231**	**105578**	**105430**	**108136**	**103203**	**103475**
2018	**100497**	**107610**	**105238**	**100310**	**100386**	**103496**	**108927**	**105043**	**104516**	**105115**

Table 24. Kopik test results

	Number of error	Kopic LR statistics	Critical value	The result of the null hypothesis test
$\alpha = 0.9$	**0**	**2.1472**	**2.706**	confirmed
$\alpha = 0.95$	**0**	**2.1021**	**3.8415**	confirmed
$\alpha = 0.99$	**0**	**5.7789**	**6.6349**	confirmed

Conclusion and suggestion:

The aim of this study is to design an optimal bank resource allocation model and reduce risk by dissociating the Perv. In order to achieve this, the objective functions are defined to minimise the risk and maximize the wealth. Moreover, the robust optimization model has been used by both particle and genetic algorithms. Moreover, for estimation of SPP-CVAR values, there are different methods which in this study, the historical method was used for

estimation. The statistical population of the research included all branches of a bank in 2014-2018, which includes 38 branches In order to collect the necessary data, the Financial Audit Analytics Method was used.

The following are:

- At all levels of confidence (0.9, 0.95 and 0.99) and the optimal risk values are based on the estimation of SPP-CVAR method using particle size algorithm (PGA), which shows the PGA algorithm performance better than genetic algorithm.

- The values of the first goal function, obtained from the PSO algorithm, for all confidence levels are lower than those of the genetic algorithm.

- The PSA time for the confidence level of 0.9, 0.95 and 0.99 is less than the time since the genetic algorithm was implemented.

- For three levels of 0.9, 0.95 and 0.99, the value of the LR peak value for the SPP- CVAR method is less than the Chi-method, which can be considered acceptable. The historical simulation method at two levels of 0.95 and 0.99 has an appropriate assessment for SPP- CVAR.

Applied suggestions

- Banks are offered to pay attention to property, capital, income, operational profits and soudis for investment and shopping.

- The are offered to help the branches, experts and experts, and to invest according to the scientific results.

- Bank managers and shareholders are to restructure their mission and strategic objectives and improve their strategic plan by studying policy research and successful global banks. These banks will take the necessary measures to increase their growth, profitability, risk management and increase their market share.

Suggestions for future research

- From other algorithms such as whale, SPEA-II, DE, COA, etc. use to optimize.

- Increase the time period of research.

- It is suggested that the same investigation with other private and government banks operating in Iran In addition, the results were compared with the results of this study.

- It is recommended that factors affecting the quality of services are identified and prioritized using fuzzy analysis.

- Identification and investigation of other factors affecting equipping and allocating resources such as facilities rate, gold and coins rate, deposit rate and inflation rate, internal environment of branches and information technology in bank

- Investigation of interest rate of bank branches based on available resources and facilities and compare it with other government and private banks
- Investigation of the role of intellectual capital, expertise and skills of employees in equipping and allocating banking resources
- Comparison of successful and unsuccessful branches of bank in equipping and allocating bank resources and identifying the factors affecting the success of branches

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