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MEASURING THE EFFICIENT INVESTMENT PORTFOLIO USING OBJECTIVE PROGRAMMING GPM, AN ANALYTICAL STUDY IN THE IRAQI STOCK EXCHANGE

BY

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Abstract

The research aimed to construct the investment portfolio using a new method, which is the objective programming method. The study was conducted in the Iraqi Stock Exchange, which included (15) joint stock companies from various sectors. According to the statistical tests, the returns of these companies were calculated, as well as their risks measured by the beta coefficient. The ability of the objective programming model to efficiently allocate the assets of the investment portfolio and determine the number and type of assets according to the investor's desire was demonstrated. The research recommended using this statistical method to resolve the conflicting objectives between the return and risk of the portfolio and the number and type of assets required in it.

Keywords: Efficient investment portfolio, return and risk, objective programming.

Introduction

Investment is a crucial step in enhancing wealth, and it is essential to do so in a correct manner, as it is often accompanied by risks that may lead to the loss of the invested capital. Therefore, investors should diversify their investments, and the investment portfolio is a tool that helps achieve this goal. Researchers have used various methods to construct an investment portfolio, including the diversification method based on the correlation coefficient between the portfolio's assets, which achieves a better trade-off between return and risk.

However, these methods lack the ability to achieve multiple objectives simultaneously, such as maximizing return, minimizing risk, determining the number and type of assets, and considering the investor's preferences. To address these challenges, we used the objective programming method, which is based on identifying the problem, formulating it, building a model according to the investor's data, testing alternatives, and selecting the best one to construct the investment portfolio.

The method considers the objective function and constraints as goals. To apply the model and test the research hypotheses, a group of companies was selected from the Iraqi Stock Exchange, and an investment portfolio was constructed. The portfolio's return and systematic risk were calculated using the beta coefficient, and the companies were classified into three levels based on the beta coefficient: higher than the market beta, equal to the market beta, and lower than the market beta.

Section One - Research Methodology

First. Research Problem

The conflict between return and risk is one of the most important problems facing researchers in the field of financial management, and their attempts to adapt to the direct relationship between them. The purpose of investment is to maximize return and minimize risk. Despite the many methods used to neutralize the relationship between return and risk, the research problem lies in using the objective programming method to solve the problem of return and risk, and building an efficient investment portfolio with the highest possible return and the lowest possible risk, while taking into account the investor's preferences.Research Questions:

1. The possibility of building an efficient investment portfolio that meets the desires of investors using the objective programming method.
2. The ability of the objective programming model to solve the conflicting objectives between return and risk.

3. The possibility of converting the constraints represented by the components of the investment portfolio into objectives that are consistent with the type of investor.

Secondly. The Importance of the Research

The importance of the research lies in using a method that is not part of financial management methods, but rather part of the field of operations research, to provide the best way to measure return and risk without sacrificing some components of the investment portfolio in favor of others, which reflects in maximizing the benefits of financial investment, and taking into account the resources used in the portfolio and determining their type and quantity according to the investor's preferences.

Third. Research Objectives

The research aims primarily to use the objective programming model to achieve the optimal allocation of investment portfolio assets, achieving the best trade-off between return and risk, and maximizing investment returns. The research also aims to:

1. Introduce the concepts of efficient investment portfolio, return, and risk.
2. Introduce the concepts of objective programming and its application in resolving conflicting objectives.
3. Build an efficient investment portfolio that meets the aspirations of investors.

Fourth. Research Hypotheses

The research is based on a main hypothesis that the objective programming model is capable of efficiently allocating investment portfolio assets and achieving the highest possible return with the lowest possible risk. The following sub-hypotheses are derived from this main hypothesis:

1. Determining the number of investment portfolio assets according to the investor's preference.
2. Selecting the type of investment portfolio assets according to the investor's preference.

Fifth. Research Population and Sample

The research population is the Iraq Stock Exchange, which includes a number of joint stock companies belonging to different economic sectors. The research sample is limited to a number of these companies, including the shares of (15) companies operating in it during the year. Based on the published data of these companies on the Iraq Stock Exchange website (www.ise), the annual returns and expected return for each share were calculated, as well as the market risk measured by the beta coefficient, to be used as inputs for the objective programming model.

Sixthly. Statistical Methods

A set of software was used, including (word, excel, spss), in addition to statistical and financial tools, including (arithmetic mean, beta coefficient, and expected return rate to calculate stock returns. The goal programming statistical software was also used to calculate the issues related to goal programming to determine the outputs and test the hypotheses.

Section tow - Theoretical Framework of the Research

The first Requirement: Basics of Investment Portfolio

Firstly. Concept of Investment Portfolio

The investment portfolio and its theory have occupied a large space in investment literature due to its primary role in establishing sound investment principles for assets in general. The concept of investment portfolio came as a reaction to the prevailing belief that reducing the level of risk is determined by holding a large number of securities regardless of the quality of these securities.

Markowitz is one of the pioneers who formulated the assumptions of portfolio theory (Alwan, 2009: 183). Therefore, the investment portfolio was defined as a composite tool of investment tools consisting of two or more assets and is managed by a single person responsible for it, called the portfolio manager (Matar, 2009: 107).

Or as a set or combination of assets that may be real or financial or a mix of both types of assets, and a specific investor decides to form it to achieve a return commensurate with a certain level of risk through diversification of its components (Al-Douri, 2010: 199). It was also defined as a combination of investment tools that include financial tools and real tools, and all money directed for benefit and dedicated to investment and profit-making (Al-Saadi, 2009: 117). It should be noted that the portfolio is a set of financial assets or investments, and its investment return is measured according to the following equation: (Mohammed, 2010: 37)

$$A = \sum_{i=1}^{n} WiBi \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where: A = Portfolio Return, Wi = Relative weight of asset i (proportion of income allocated for investment in it), Bi = Return of asset i.

Second. Types of Investment Returns

Return is one of the topics that interests all investors, whether individuals or institutions, because of the increase in the investor's capital that results from it. Therefore, some have defined it as the realized or expected increase that is obtained when investing (Al-Momani, 2008: 73). Or it is the return on shares that is paid on investments, where these shares differ in importance depending on the investor's need for them (Hussein, 2009: 207).

However, such investment returns are often accompanied by a set of risks that make the investor stop and be cautious in his investments (Kadawi, 2009: 16). Or it is the compensation that the investor hopes to obtain in the future in return for investing his money (Alwan, 2009: 48.(In another concept, it is the desire of the investor, whether an individual or a company, to obtain a return commensurate with the level of risks resulting from the investment process (Al-Douri, 2010: 55). It includes several types:

1. **Actual Return:** It is the returns that the investor achieves from acquiring or selling the investment, and may be income or capital returns or a mix of both.To measure the actual return on investment from the total assets, which represents the amount invested in generating profits after tax, according to the following formula: (Ramadan, 2007: 294).

Actual Return Rate = Net Profit after Tax ÷ Invested Amount ……….......(2)

The net profit includes both income and capital profits during the year only.

2. **Required Return:** It represents the return at its lowest level that the investor requires before starting any specific investment, and is calculated according to the following formula: (Al-Saadi, 2009: 81).

Required Return Rate = Expected Dividend for the First Year ÷ Market Value of Ordinary Share + Expected Growth Rate in Dividend .... ….. (3)

3. **Expected Return:** It is the rate of return that the investor expects to obtain in the future, and in general, it is the arithmetic mean of the rates likely to be achieved in the future. This measure is one of the most important and best measures that interest the investor, especially one who owns a financial portfolio, as shown in the following formula: (Al-Momani, 75: 2013)

$$ERi = \sum_{i=1}^{n} RiPi \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (4)$$

Where:ERi = Expected Return on Investment, Ri = Return on Investment during a specific period, Pi = Probability of achieving the return during a specific period

Thirdly. Investment Portfolio Risk

There is a fundamental relationship between return and risk, which in turn affects investment decisions. The higher the degree of risk associated with the investment, the higher the required rate of return to compensate for that risk. This situation reflects the positive relationship between them according to modern portfolio theory (Al-Zalmi, 2013: 32). Or it is the systematic and unsystematic fluctuations that occur in the values of investment assets and their expected returns under conditions of uncertainty prevailing in financial markets and economic activities (Ma'ruf, 2009: 253).

Or it means the failure of the investor to obtain the expected return on investments, and risk is measured by the standard deviation of the actual return from the expected return (Matar, 2009: 52). Or it is the degree of uncertainty that the investment will achieve the expected rate, and that is when the actual real return is less than expected (Al-Douri, 2010: 66). Any irregularity in returns, the fluctuation of these returns in value or in relation to the invested capital is what constitutes the risk element (Alwan, 2009: 61).The investment portfolio is exposed to two types of investment risks according to the majority of researchers:

1. **Systematic Risk**: It is the risk resulting from factors that affect all companies without exception, This risk has several sources, including:(Matar, 2009: 52).

- Interest rate risk, which means that investments are affected by fluctuations in interest rates, so interest rates have an inverse effect on the prices of securities and other investments (Ma'ruf, 2009: 260).

- Inflation risk, which means the risk of the purchasing power of the currency and negatively affects some securities, where it liquidates its investments in bonds and directs them to more profitable investments such as stocks (Al-Momani, 2008: 80).
- Market risk, meaning that market movements affect investment returns as a result of risks that affect companies in general, such as speculation in securities, political changes, and wars. These risks affect investor behavior (Alwan, 2009, 64).

2. **Unsystematic Risk**: It is the risk resulting from factors related to a specific company or sector and is independent of the factors affecting the economic activity as a whole, There are sources of these risks, including:(Alwan, 2009: 59)

- Industrial risks: Due to special circumstances that occur in a specific type of industry, such as the emergence of new inventions, the emergence of new competitors, or the inability to compete and the difficulty of providing raw materials, which affects the cash flows of a company (Alwan, 2009: 65).
- Management risk: These risks come from wrong management decisions, and these decisions affect the company's activity and profit achievement and are reflected in the company's shares in the securities market (Al-Momani, 2008: 82).
- Commercial risks: It refers to the commercial cycles that appear on a specific company, leading to fluctuations in the company's profits and occur at irregular times and for reasons outside the financial market conditions, making it difficult to predict their occurrence (Al-Douri, 2010: 208).

Third. The Relationship between Return and Risk

The expected return on investment for any project is related to the degree of risk associated with the project, because the relationship is direct between return and risk, meaning that the higher the risk, the higher the expected return on investment. Therefore, the investor must balance between return and risk (Salem, 2010: 97). Therefore, the investor makes great efforts to reduce the probability of exposure to risks, but there is a contradiction between increasing the reward and reducing the risk, as increasing returns carries with it an increase in risks, and it is not easy to establish a fixed relationship between profits and risk. The investor must evaluate the rates of profit and the resulting rates of risk (Al-Saadi, 2009: 21).

The return and risk are linked together in a direct relationship, meaning that the higher the investor's ambition to achieve a higher return on his investments, the more he must prepare himself to bear high degrees of risk, and vice versa (Matar, 2009: 22).When the investor invests in a specific field, he is exposed to risks, and therefore there must be a return commensurate with the degree of risk borne by the investor, and the reciprocal relationship between the expected return and the risks associated with it for each type of asset. A rational investor in his decisions will not be willing to bear a high level of risk unless it is accompanied by a high return, and thus the relationship is direct between return and risk (Alwan, 2009: 69).

Fourth. Statistical Tools for Measuring Risk

There are many methods for measuring risk, including systematic and unsystematic risks. Systematic risk is measured using the beta coefficient, which is a measure of the stock's risk and the extent to which the return is affected by changes in the market return, while unsystematic risk is measured using dispersion and standard deviation measures (Ramadan, 2007: 345):

1. **Beta Coefficient.** It means the speed and extent to which market risks affect the individual stock, where each stock has a beta to measure the extent to which the stock is affected by market risk, and it can be calculated according to the following formula: (Al-Momani, 2013: 84).

$$\beta = \frac{cov(\bar{R}m.\bar{R}j)}{v.\bar{R}m} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (5)$$

Where:β = Beta Coefficient, Cov(Rj.Rm)= Covariance between stock return Rj and market return Rm, Rj = Expected return of the stock, Rm = Expected return of the market portfolio, v.Rm = Variance of market return Rm.

Beta is considered the best measure of systematic risk, as it measures in the same way that the expected return of the portfolio is measured, and represents the weighted average of the beta that enters into the composition of the portfolio, according to the following formula: (Al-Douri, 2010: 248)

$$\beta p = \sum_{i=1}^{n} W\text{i} \times \text{bi} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (6)$$

Where:βp = Portfolio Beta, representing the impact of the portfolio on the market, Wi = Weighted average of the stock in the portfolio, bi = Beta coefficient of the stock in the portfolio.

2. **Standard Deviation.** It is the square root of the variance that measures the dispersion of expected investment returns from their arithmetic mean. Therefore, an increase in the level of dispersion indicates an increase in risk.

$$\partial = \sqrt{\sum_{i=1}^{n} pi\left(ri - E(ri)\right)^2} \ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

Where: :∂= Standard Deviation, Pi = Probability of return occurrence, ri = Actual investment return, E(ri) = Expected value of investment return, $\left(ri - E(ri)\right)^2$= Squared deviation of investment returns from their expected value.

3. **Variance.** It is a measure of the deviation of the investment from its arithmetic mean and how the returns on investment are distributed in financial markets. It represents most investments that are symmetrical around the arithmetic mean.

$$\partial^2 = \frac{\sum(xi - \overline{xi})^2}{N-1} \ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$$

Where; ∂^2= Variance, xi = Return on investment, $\overline{xi}$= Average return on investment, N = Number of investment.

Sixth. Efficient Diversification

Efficient diversification, also known as Markowitz diversification, is a diversification strategy that, unlike simple diversification, requires careful selection of investments to consider the correlation coefficient between the returns generated by them and the risk. There is a direct relationship between the returns on investments that make up the portfolio and the risk it is exposed to, which is greater than if those returns were independent. Markowitz concluded that the lower the correlation coefficient between the returns on individual investments, the lower the risk to which the return is exposed, and that this diversification may succeed in eliminating unsystematic risk and part of systematic risk (Mohammed, 2010: 42). Efficient diversification is the key to risk management, and through appropriate diversification, exposure to risk may decrease without affecting the expected return on the portfolio (Al-Rawi, 2009: 191). Diversification reflects the marginal utility of invested funds, which means that the investor distributes their funds among types and amounts of securities to reduce risk and maximize returns (Alwan, 2009: 187). The formation and diversification of portfolio assets also depends on diversifying the issuing entity, meaning that the securities invested in the portfolio should not be from a single entity (Al-Momani, 2008: 131).

Second Requirement. Goal Programming

First. Concept of Goal Programming

The mathematical formulation of economic phenomena is not new in the theoretical field, but its use has taken a prominent place after the rapid progress in the use of electronic computers to find digital solutions to complex relationships that are difficult to solve, and mathematical analysis aims to search for how to achieve economic efficiency in the use of resources in cases that are difficult to reach under theoretical readings (Al-Hamdani, 2002: 133).

Goal programming is one of the branches of mathematical programming models that deals with the problem of allocating resources to achieve specific goals, and the basic idea of programming is to find a solution to the problems faced by management in formulating goals, as management is sometimes forced to abandon some goals in favor of others. Through the name of goal programming, it came to compare goals and resolve conflicting ones, as the most important goals are selected from among the less important goals and achieving the goals that the owner of the management wants to achieve, making it closer to reality.

Goal programming seeks to achieve more than one goal at the same time, unlike linear programming, which works to achieve one goal, considering this goal that linear programming achieves is the best goal that can be achieved (Phillips & James, 1996: 13). The term programming is a method of evaluation that takes software development practices that are agreed upon as good development practices and pushes them to the extreme in practice (Al-Mahmoud, 2008: 135), while the term goal is considered a target function and the function to be maximized or minimized, usually in a monetary or natural form, depending on the formulation of the problem to be achieved, as shown in the following formula: (Al-Hamdani, 2002: 135).

$$Subjectto = \sum_{i=1}^{n} aijxi = (\leq, =, \geq)bj \dots\dots..(10)$$

Where:aij = Quantity of resource i required to produce one unit of activity j, xi = Decision variable representing the level of activity j, bj = Available amount of resource i.

If the increase in the objective function is not achieved, it means a shortage in achieving the goal, denoted by (di)‾. If a surplus is achieved due to that increase, it is denoted by di.+ Equation: (Schniederjans, 1984: 98)

$$\sum_{j=1}^{n} aijxi + \bar{d}i - \overset{+}{d}i = bj \dots\dots\dots\dots\dots\dots\dots (11)$$

Where:n = 1, 2, 3, ..., m

The goal programming model works to minimize the deviations between the desired goals to be achieved and determine their priorities, and it is formulated as an objective function: (Lee, 1982: 69)

$$Minimize \dots..z = \sum_{j=1}^{n} \left(\overset{+}{d}i + \overset{-}{d}i\right) \dots\dots\dots\dots\dots (12)$$

Goal programming is a linear programming approach for multi-criteria or multi-objective decision problems. It is characterized by its flexibility in making adjustments and transformations in the pattern of priorities in the face of rapid and random changes in the economy. This is a special feature of goal programming, as it shows the decision-maker the amount of sacrifices that can be made according to the preferences desired.

Therefore, goal programming is a comprehensive approach that combines the standard approach and dynamic programming. The similarity between them is that they are used to estimate the relationship between economic variables quantitatively and measure the sensitivity of the relationship between different economic variables and the extent of their impact on each other through the calculation of statistical coefficients and comparison between economic policies and alternative policies. Goal programming takes into account the random element that has been neglected by both economic theory and mathematical economics, despite the importance of assuming relationships between economic phenomena that have sought to address this random element contained in economic relationships (Al-Hamdani, 2002: 170).

Goal programming is similar to dynamic programming in that it is used to modify previous decisions and is distinguished in solving a certain type of problem, especially large problems, in order to reach the optimal solution. It can also be used to develop an optimal policy for distributing resources to economic sectors in order to maximize the return from those sectors within the constraints imposed on them, meaning that it provides an optimal policy for each sector in addition to achieving the highest total return for the economic system as a whole (Al-Hamdani, 2002: 183).

Second. Components of Goal Programming

There are three main parts in the goal programming model, as follows: (Al-Hamdani, 2002: 176)

1. Objective Function: It is the goal that the decision-maker seeks to achieve by minimizing the deviations or differences between goals.
2. Constraints: Represent the volume and types of resources, and can be of type ≥ only, ≤ only, or equal to.
3. Non-Negativity Constraints of Decision Variables: Decision variables must be equal to zero or greater than zero, and if they are negative, they can be modified by multiplying the equation by a negative integer (-1).

Third. General Formulation of the Goal Programming Model

The goal programming model can be formulated as follows: (Zeleny, 1982: 285-286)

1. Objective Function:

$$Minimize \dots Z = \sum_{i=1}^{n} pi^{-} di^{-} + \sum_{i=1}^{n} pi^{+}\, di^{+} \dots (13)$$

2. Constraints:The model constraints are divided into resource constraints and goal constraints, as follows:

- Resource Constraints:

$$\sum_{i=j}^{n} ajxi < k \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (14)$$

- Goal Constraints:

$$\sum_{i=j}^{n} Bjxi - d_i^{+} + d_i^{-} = R \dots\dots\dots\dots (2-14)$$

3. Non-Negativity Conditions:

$$d_i^{+}, d_i^{-}, xi \geq 0 \dots\dots\dots\dots\dots\dots\dots.... (2-15)$$

Where: pi^{-}= Priorities of positive deviations from goals, pi^{+}= Priorities of negative deviations from goals, d_i^+ = Positive deviations from goal, d_i^-= Negative deviations from goal, xi= Decision variables, aj = Technical coefficients, Bj = Available resources, k = Quantity of resources available to the decision-maker, R = Target level set by management.

Section Three - Practical Aspect

In this section, the hypotheses are tested according to the operational methodology, which begins with measuring the return and risk of the portfolio in the Iraq Stock Exchange for a group of joint stock companies, and then attempting to form an efficient investment portfolio that gives us the best trade-off between return and risk, taking into account the investor's preferences and limited resources. Therefore, the goal programming approach will be applied to create a balance between all these goals and determine their priorities.

First. Measuring Stock Return and Risk

According to the research sample, which consisted of (15) shares from different companies listed on the Iraq Stock Exchange, the investment ratio of each to the total investment in the portfolio was extracted, and the expected return rate for each share was measured using equation (1-3). The opening and closing prices of these companies were taken into account, in addition to the dividend distributed by these companies to extract the expected return rate.

The systematic risk of the share was also measured according to equation (1-4), as shown in Table (3-1), which shows the investment ratio, expected return rate, and systematic risk of the share. The shares were arranged according to the size of the systematic risk measured by the beta coefficient, in addition to calculating the arithmetic mean of the return rate and portfolio risk according to equations (1-6) and (1-4), respectively.

Table (3-1) Expected Stock Return and Systematic Risk

N	Company	Investment Ratio	Expected Return Rate	Beta |
1	Ishtar Hotels	0.06	0.16	0.12
2	Nineveh Food Industries	0.14	0.39	0.31
3	Al-Kindi Veterinary Vaccines	0.03	0.08	0.55
4	Gulf Bank	0.06	0.18	0.73
5	Baghdad Bank	0.07	0.19	0.86
6	Al-Wiam Financial Investment	0.08	0.23	0.98
7	Al-Warka Bank	0.07	0.19	1.00
8	Iraqi Carton Industry	0.03	0.08	1.00
9	Babylon Bank	0.05	0.14	1.00
10	Iraq Islamic Bank	0.07	0.19	1.12
11	Al-Amin Real Estate	0.09	0.25	1.14
12	Eastern Beer	0.05	0.14	1.22
13	Baghdad Packaging Materials	0.09	0.26	1.39
14	Ready-Made Clothing Production	0.05	0.14	1.50
15	Iraq Investment Bank	0.08	0.23	1.87
Mean	Iraq Market	0.068	2.85	1.00

It is observed from the above table that the highest expected return rate was for Nineveh Food Industries within the industrial sector, which was (0.39) with a systematic risk of (0.31), and the lowest expected return rate was (0.08) for Al-Kindi Veterinary Vaccines with a systematic risk of (0.55). The researcher also presented the systematic risk measured by the beta coefficient in descending order, starting from Al-Warka Bank, which was (1.00), to Iraq Investment Bank (1.87).We assume this practical example to know how to use the goal programming approach in allocating shares within the efficient portfolio, as an investor wants to invest an amount of money of (100,000,000) one hundred million Iraqi dinars as follows:

- Investing (70) million dinars in shares with a risk lower than the average (market risk).
- (20) million dinars in shares with a risk equal to the average (market risk) of (1).

- (10) million dinars in shares with a risk higher than the average (market risk).

According to these goals and priorities, which are ranked according to their importance, a goal programming model can be formulated to select the appropriate mix of shares to form an efficient investment portfolio.

Second. Applying the Goal Programming Model:

To apply the goal programming model, the goals and priorities should be determined, which are:

1. The expected return of the stock is greater than or equal to the average return of the market portfolio.
2. The risk of the stock is less than or equal to the risk of the market portfolio.
3. The investment ratio should not be less than 70% in low-risk stocks with a risk lower than the market risk.
4. The investment ratio is 20% in stocks with a risk equal to the market risk.
5. The investment ratio should not exceed 10% in high-risk stocks with a risk higher than the market risk.
6. The investment ratio is 100% in the total investment portfolio.

In light of these goals and priorities, the objective function is:

The goal programming model equation is:

$$\text{Minimize} \ldots .\, z = p1\bar{d}1 + p2d2 + p3\bar{d}3$$
$$+p4\left(d4 + \bar{d}4\right) + p5d5 + p6\left(d6 + \bar{d}6\right)$$

1. Constraint: Increase the expected return of the stock to be greater than or equal to the market portfolio:
$$Ri = d1 + \bar{d}1 \geq (0.194)$$
2. Constraint: Reduce the risk of the stock to be less than the market portfolio:
$$\beta = d2 + \bar{d}2 \leq (1.00)$$
3. Constraint: Risk of stocks with a risk level lower than the market risk:
$$\sum_{i=1}^{100006} \beta - d3 + \bar{d}3 \geq \%70$$
4. Constraint: Risk of stocks with a risk level equal to the market risk (1):
$$\sum_{i=1}^{7000} \beta - d4 + \bar{d}4 = \%20$$
5. Constraint: Risk of stocks with a risk level higher than the market risk:
$$\sum_{i=1}^{1500015} \beta - d5 + \bar{d}5 \leq \%10$$
6. Constraint: Investment ratio in the portfolio:
$$\sum_{i=1}^{15} Wi - d6 + \bar{d}6 = \%100 = 100{,}000{,}000$$

The Optimal Solution for Forming an Efficient Investment Portfolio:

After applying the goal programming model through the QSB program, the optimal solution was reached, taking into account the priorities desired by the investor, as shown in the following table:

Table (3-2) The Optimal Solution for the Efficient Investment Portfolio

Decision	Solution	Basis	Reduced Cost	Reduced Cost	Reduced Cost	Reduce d Cost	Reduced Cost	Reduced Cost
Variable	Value	Status	Goal 1	Goal 2	Goal 3	Goal 4	Goal 5	Goal 6
X1	0	at bound	0	0	0	0	0	0
X2	7.21	Basic	0	0	0	0	0	0
X3	0	at bound	0	0	0	0	0	0
X4	0	at bound	0	0	0	0	0	0
X5	0	at bound	0	0	0	0	0	0
X6	0	at bound	0	0	0	0	0	0
X7	0.2	Basic	0	0	0	0	0	0
X8	0	at bound	0	0	0	0	0	0
X9	0	at bound	0	0	0	0	0	0

X10	0	at bound	0	0	0	0	0	0
X11	0	at bound	0	0	0	0	0	0
X12	0	at bound	0	0	0	0	0	0
X13	0	at bound	0	0	0	0	0	0
X14	0	at bound	0	0	0	0	0	0
X15	0	at bound	0	0	0	0	0	0
d^+	0	at bound	0	0	0	0	0	0
d^-	0	at bound	1	0	0	0	0	0
d^+	0	at bound	0	1	0	0	0	0
d^-	0	at bound	0	0	1	0	0	0
d^+	0	at bound	0	0	0	0	0	0
d^-	0	at bound	0	0	0	1	0	0
d^+	0	at bound	0	0	0	0	0	0
d^-	0	at bound	0	0	0	0	1	0
d^+	0	at bound	0	0	0	0	0	0
d^-	0	at bound	0	0	0	0	0	1
d^+	0	at bound	0	0	0	0	0	0
d^-	98.98	Basic	0	0	0	0	0	0
Goal 1	Minimize	G 1 =	0					
Goal 2	Minimize	G 2 =	0					
Goal 3	Minimize	G 3 =	0					
Goal 4	Minimize	G 4 =	0					
Goal 5	Minimize	G 5 =	0					
Goal 6	Minimize	G 6 =	0					

Source: QSB program outputs

after applying the goal programming model according to the priorities and goals desired by the investor, the above table (3-2) shows that it is possible to achieve all goals according to the priorities ranked according to importance, where the value reached (0), as shown in table (3-3) the basic variables (X2 = 7.21, X7 = 0.2) within the constraints representing the resources that should be taken into consideration if we want to achieve all goals and priorities, as shown in table (3-3)

Table (3-3) Positive and Negative Deviations in Goals

Constraint	Left Hand Side	Direction	Right Hand Side	Slack Or Surplus	Allowable Min. RHS	Allowable Max. RHS	Shadow Price Goal 1	Shadow Price Goal 2	Shadow Price Goal 3	Shadow Price Goal 4	Shadow Price Goal 5	Shadow Price Goal 6
C 1	2.85	>=	2.85	0	0.95	19.80	0	0	0	0	0	0
C 2	2.36	<=	15.40	13.04	2.36	M	0	0	0	0	0	0
C 3	2.16	>=	0.70	1.46	-M	2.16	0	0	0	0	0	0
C 4	0.20	=	0.20	0	0	10.21	0	0	0	0	0	0
C 5	0	<=	0.10	0.10	0	M	0	0	0	0	0	0
C 6	100	=	100	0	1.02	M	0	0	0	0	0	0

Source: QSB program outputs

Where Table (3-3) (3-3) shows the positive and negative deviations of the constraints from the goals, where:

- Constraint 1 (Slack C1 = 0): No deviation from achieving the goal, can be reduced to (Min 0.95) or maximized to (Max 19.80), achieving a higher expected return than the expected return of the investment portfolio according to the investor's desire.
- Constraint 2 (C2 = 13.04): Negative deviation, cannot achieve market goal except after adjusting basic variables X2, X7), can be reduced by (2.36).
- Constraint 3 (C3 = 1.46): Positive deviation, can maximize this goal by (Max 2.16), investing 70% of the money in stocks with a risk lower than the market risk.
- Constraint 4: Can maximize goal to (Max 10.21), investing 20% of funds in stocks with a risk equal to the market risk.
- Constraint 5 (C5 = 0.10): Negative deviation, cannot be reduced, this ratio (0.10) is the highest maximization, cannot achieve this goal except after adjusting basic variables (X2, X7).
- Constraint 6: No deviation from achieving goal, can be reduced by %1.02, reducing the invested amount (100,000,000) while achieving previous goals.

Accordingly, and according to the outputs of the goal programming, it is possible to prove the validity of the main research hypothesis stating (that the use of goal programming leads to achieving the efficient allocation of investment portfolio assets by achieving the highest possible return with the lowest possible risk), as well as it is possible to prove the first sub-hypothesis (the ability of the goal programming model to determine the number of investment portfolio assets according to the investor's desire), and prove the second sub-hypothesis stating (the ability of the goal programming model to select investment portfolio assets according to the investor's desire).

Section Four - Conclusions and Recommendations

Firstly, Theoretical and Practical Conclusions

Through the review of the theoretical and practical aspects of the research, a set of conclusions have been reached, which will be presented as follows:

1. Risk is an inevitable thing that accompanies investment and achieving returns, and it is directly related to the return.
2. Ordinary shares are exposed to a set of risks, and the most important of these risks is the systematic risk, which is measured by beta, and the non-systematic risk, which can be avoided through diversification, as the increase in such risk affects the increase in the reluctance of investors in the Iraqi Stock Exchange.
3. The investment portfolio is a good way to reduce the risk of ordinary shares, and the best of these portfolios is what is formed on the basis of efficient diversification.
4. The measurement of investment portfolios is not limited to traditional financial methods, but can be measured by operations research methods, such as goal programming, which is one of the modern methods in achieving conflict between goals.
5. It is possible to achieve conflicting investment goals within a single portfolio, in terms of increasing the expected return, reducing risk, and diversifying investment in different stocks.
6. The goal programming model is able to achieve the goals of investors, whether individuals or companies, and meet their desires by reaching the optimal solution, which is the closest possible to the goals, and which can be fully achieved if some required resources are added.

Secondly, Research Recommendations

The recommendations are the final outcome of the research to address the problem being researched, and the research has reached a set of recommendations, which are as follows:

1. When investing in a set of stocks, consideration should be given to forming an investment portfolio according to efficient diversification to reduce the risk of investment, which would increase the wealth of investors.
2. Using the goal programming model in measuring and diversifying stocks within the investment portfolio, which is characterized by its ability to combine conflicting goals and achieve them within the priorities set by the investor.
3. The ability of the goal programming model to construct an investment portfolio that takes into account the investor's desire for the amount of

return, the amount of risk avoidance, and the number of assets in it, and what type of assets these are.

4. Updating the electronic information on the website of the Iraqi Stock Exchange, which lacks much of the important information required by researchers to identify the most important financial problems in this market.
5. The goal programming model greatly helps managers in making decisions for all aspects of the financial and administrative organization, so it should be used by them.

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