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Building an investment portfolio using the (Kataoka) model: An applied study on a sample of industrial companies listed on the Iraq stock exchange for the period (2020-2024)

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Abstract
The research aims to construct an investment portfolio using the (Kataoka) model as one of the behavioral approach models in portfolio construction and compare it with the market portfolio built within the study framework of the trade-off between return and risk. The study relies on data from the Iraq Stock Exchange ISX60 index. The research sample consists of ten industrial companies listed on the Iraq Stock Exchange, and the quarterly closing prices of these companies' stocks were analyzed for the period from January 1, 2020, to September 30, 2024. The data was processed using Excel (Solver packages). The study reached several findings, the most important of which is that the portfolio constructed based on the (Kataoka) model outperforms the market portfolio built in the study in terms of the trade-off between return and risk. One of the key recommendations of the research is that investors should utilize this model when forming their investment portfolios rather than diversifying randomly to ensure the benefits of portfolio investment with minimal risk.

Keyword: Investment portfolio, (Kataoka) model, return and risk, Iraq stock exchange

Introduction
The portfolio theory plays a crucial role in enhancing the quality of investment decisions made by financial managers and investors. Efficient management of an investment portfolio, which naturally includes two or more financial assets, contributes to investment diversification to achieve optimal performance within the framework of the trade-off between portfolio returns and risks. This, in turn, enhances the ability to plan investments and make investment decisions based on well-studied and clear steps. Numerous scientific models are constructed in the form of mathematical formulas and frameworks for portfolio formation and management, assuming that investors are always rational and logical in their decision-making. Conversely, several behavioral models for portfolio construction assume that investors are not always rational, as behavioral determinants and influencing factors compel investors and portfolio managers to make many decisions based on behavioral influences surrounding investment activities rather than purely rational considerations. Among these behavioral models is the one developed by Kataoka (1963) [6], which aims to achieve the optimal composition of portfolio assets. The motivation for conducting this research lies in its significance in determining whether an investment portfolio constructed using the Kataoka model, as one of the behavioral models, can achieve better performance than the market portfolio within the framework of the trade-off between return and risk. To achieve the research objectives, the study is divided into four sections: The first section presents the methodological framework of the study, The second section discusses the theoretical framework of the study, The third section focuses on portfolio formation using the Kataoka model, The fourth section presents the conclusions and recommendations derived from the research.

First Section: Methodological Framework

First: Research Problem

Financial managers and investors in financial markets typically seek to safeguard their investments by constructing investment portfolios that include two or more financial instruments. This diversification aims to achieve the best trade-off between return and risk. Portfolio theory has introduced numerous scientific models to facilitate the process of attaining the optimal composition of portfolio assets. However, these scientific models, which assume the perpetual rationality and logical decision-making of investors, have encountered a reality that differs from the principles and assumptions of optimality models. Behavioral determinants and influencing factors often compel financial managers and investors to make investment decisions that deviate from the rationality and logic assumed by scientific models in portfolio construction. This discrepancy presents a critical issue that necessitates examining the extent to which behavioral approach models contribute to investment portfolio construction, particularly the Kataoka model and other behavioral finance models. The research problem can thus be formulated in the following key question:

1-Can an investment portfolio constructed using the Kataoka model achieve better performance than the market portfolio within the framework of the trade-off between return and risk?

Second: Research Significance

The significance of this research stems from its attempt to assess the contribution of the Kataoka model as one of the behavioral finance models in constructing investment portfolios to achieve an optimal trade-off between return and risk. Through this, the study explores important research variables and aims to present a conceptual framework that describes the nature of investment portfolios while also addressing the Kataoka model as one of the most prominent behavioral finance models. On a practical level, the study gains additional importance by selecting a sample of companies operating in the Iraqi industrial sector, aiming to provide recommendations that may assist these companies in adopting and identifying effective models for constructing their investment portfolios.

Third: Research Objectives

This study seeks to achieve the following objectives:

1. Presenting a conceptual framework that reflects the theoretical nature of the research variables.
2. Assessing the performance of an investment portfolio constructed using the Kataoka model in comparison to the market portfolio, within the framework of the trade-off between return and risk.

Fourth: Research Hypothesis

To achieve the objectives of the study, the following hypothesis is tested:

"An investment portfolio constructed using the Kataoka model does not achieve better performance than the market portfolio within the framework of the trade-off between return and risk."

Fifth: Research Scope

1. **Spatial Scope:** The study examines quarterly data of stocks from ten industrial companies listed on the Iraq Stock Exchange.
2. **Temporal Scope:** The study relies on quarterly closing price data of the selected industrial companies' stocks for the period from January 1, 2020, to September 30, 2024.

Sixth: Research Population and Sample

The research population includes all industrial companies listed on the Iraq Stock Exchange (ISX60). The research sample consists of ten industrial companies, selected based on their listing duration and availability of relevant data. The selected sample represents the most actively traded companies in the quarterly market sessions, as detailed in Table (1).

Table 1: Research Sample of Companies Listed in the Iraq Stock Exchange Index

No.	Company Name	Company Code	Listing Date
1	Al-Mansour Pharmaceutical Industries	IMAP	2004/11/27
2	Modern Sewing	IMOS	2004/7/8
3	Iraqi Company for Carpets and Furnishings	ITTC	2004/7/25
4	Baghdad for Manufacturing Construction Materials	IBPM	2004/7/25
5	Baghdad for Soft Drinks	IBSD	2004/6/15
6	Iraqi Company for Manufacturing and Marketing Dates	IIDP	2004/9/4
7	Iraqi Chemical and Plastic Industries	INCP	2004/6/15
8	Al-Kindi for Veterinary Vaccines Production	IKLV	2004/7/25
9	Iraqi Metal and Bicycles Industry	IMIB	2004/7/25
10	Ready-Made Clothes Manufacturing	IRMC	2004/7/25

Source: Prepared by the researcher based on reports published on the ISX60 Index from the Iraq Stock Exchange website (http://www.isx-iq.net).

Seventh: Financial and Statistical Tools Used in the Research

1. Stock Return: Calculated using the following equation:

$$R_i = \frac{(P_t - P_{t-1}) + D}{P_{t-1}}$$

2. Standard Deviation: Calculated using the following equation:

$$\sigma = \sqrt{\sigma^2} = \sqrt{\frac{\sum \left(R_i - \bar{R}_i\right)^2}{N-1}}$$

3. Coefficient of Variation: Calculated using the following equation:

$$C.V = \frac{\sigma}{\overline{R}_i}$$

4. Beta (β): Calculated using the following equation:

$$\beta = \frac{\mathrm{Cov}(R_i, R_m)}{\sigma^2_{Rm}}$$

5. Portfolio Return (R_p): Calculated using the following equation:

$$R_p = \sum_{i=1}^{n} W_i R_i$$

6. Portfolio Standard Deviation (σ_p): Calculated using the following equation:

$$\sigma_p = \sqrt{w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2r_{1,2}\sigma_1\sigma_2}$$

7. Systematic Risk: Calculated using the following equation:

$$\text{Systematic Risk} = \beta^2\sigma^2_{Rm}$$

8. Unsystematic Risk: Calculated using the following equation:

$$\text{Unsystematic Risk} = \sigma^2_{ej}$$

9. Total Risk: Calculated using the formula:

$$\text{Total Risk} = \text{Systematic Risk} + \text{Unsystematic Risk}$$

10. Portfolio Beta (β_p): Calculated using the following equation:

$$\beta_p = \sum_{i=1}^{n} w_i \beta_i$$

Second Section: Theoretical Framework of the Research

First: The Concept of an Investment Portfolio, Its Objectives, and How It Is Constructed

1. Concept of an Investment Portfolio

The general concept of an investment portfolio refers to the combination of multiple financial and real assets formed by an investor to diversify investments, maximize returns, and manage the risks associated with the performance of these assets (Kumari, 2024:1542) [8]. Portfolio theory plays a central role in investment risk management and improving investment decision-making. Investors typically tend to avoid risks by implementing diversification strategies within the stocks and assets in their portfolio to achieve higher returns while minimizing and measuring risks (Mahmudah *et al*., 2024:33) [9]. According to Qader (2022:29) [2], an investment portfolio is a combination of financial and real assets that an investor owns to maximize returns while maintaining an acceptable level of risk exposure. Similarly, Sami (2018:235) [1] defines an investment portfolio as a composite investment tool that includes two or more assets, whether financial, real, or a combination of both, and is managed by a portfolio manager. It consists of a mix of investment alternatives that enable investors to allocate their funds efficiently into various investment opportunities (Qader & Hammed, 2024:15) [11]. Another definition states that an investment portfolio is a means through which investors manage their assets by diversifying investments to achieve a satisfactory return while maintaining an acceptable level of risk (Kazaei & Makui, 2024:58) [7]. Based on the above, the researcher defines an investment portfolio as a tool that assists portfolio managers in analyzing the relationship between return and risk to optimize performance within the trade-off framework. This is achieved by constructing a diversified mix of financial and real assets, aiming to maximize returns while maintaining an acceptable level of risk exposure.

2. Objectives of the Investment Portfolio

Every investment portfolio manager aims to achieve multiple objectives by constructing a portfolio that balances returns and risks. The main objectives of an investment portfolio can be outlined as follows:

A. Preserving Original Capital

Investing in financial markets is inherently risky and subject to uncertainty, which can expose individual and institutional investors to losses exceeding their expected returns, ultimately leading to the erosion of original capital. This highlights the necessity of constructing an investment portfolio composed of assets with varying levels of risk and expected returns to mitigate potential losses (Owaid *et al*., 2022:350) [4].

B. Diversification in Investment

Diversifying the components of an investment portfolio helps reduce the level of risk associated with it (Sami, 2018:236) [1]. The portfolio manager must actively diversify assets within the portfolio to balance returns and risks. Achieving proper diversification requires significant effort from the portfolio manager, including gathering market trend data and analyzing the investment activities of companies operating within the market (Johnson, 2006:119) [5].

C. Ensuring Liquidity

Including specific financial instruments such as stocks of large corporations and bonds in an investment portfolio ensures the necessary cash flow when needed. Each investment portfolio should contain assets that can be quickly converted into cash with minimal cost to avoid financial distress. This can be effectively achieved through a well-diversified investment portfolio (Manurung *et al*., 2024:233) [10].

3. How to Construct an Investment Portfolio

There are three fundamental principles that guide the process of building an investment portfolio.

A. Risk Preference Principle

If an investor is choosing between two investment portfolios that generate the same return but have different risk levels, the investor will prefer the portfolio with the lower risk.

B. Return Preference Principle

If an investor is choosing between two investment portfolios that are subject to the same level of risk but offer different expected returns, the investor will prefer the portfolio with the higher return.

C. Optimal Portfolio Selection Principle

If an investor is choosing between two portfolios, where the first portfolio offers a higher expected return while being exposed to a lower level of risk, the investor will choose the first portfolio.

Second: The Kataoka Model

The Kataoka model is one of the most widely used behavioral finance models among other behavioral approaches. In 1963, Kataoka proposed a model aimed at investors seeking to protect the minimum return they are willing to accept. This model was developed as a criterion similar to the "Safety-First" principle, with the goal of achieving the optimal investment portfolio. According to the Kataoka model, investors select and construct their portfolios based on a secured return known as the Insured Return which represents the maximum achievable return while ensuring that the probability of the portfolio return exceeding this secured return does not surpass a predetermined level (Qader, 2022:77-78) [2].

The mathematical formulation of the Kataoka model is expressed as follows (Valverde, 2023:30-31; Kataoka, 1963:182-183; Kojak & Muflih, 2021:60) [12, 6, 3]:

$$Maximize \ (r_l) \quad (42)$$

$$\text{s. t. } Prob\left(r_p < r_l\right) \leq a$$

$$r_l = E\left(r_p\right) + (-1.645)\,\sigma_p \quad (43)$$

Where:

r_p: Portfolio retur

r_l: Minimum return desired by the investor

a : Loss probability (5%)

σ_p: Portfolio standard deviation:

Probability that the portfolio does not exceed the specified $Prob\left(r_p < r_l\right) \leq a$: threshold

Third Section: Constructing Investment Portfolios Using the Kataoka Model

First: Analysis of Returns of Sampled Companies Listed on the Iraq Stock Exchange

Table (2) presents the return series of the sampled companies listed on the Iraq Stock Exchange during the studied period. The last column of the table shows the average returns of these companies. The highest average return was recorded by the Iraqi Company for Manufacturing and Marketing Dates, achieving a return of 0.0689. This was followed by the Baghdad Company for Packaging Materials, which achieved an average return of 0.0622. On the other hand, the lowest return was recorded by the Iraqi Company for Carpets and Furnishings, with an average return of 0.0279. Moreover, two companies suffered losses: Iraqi Metal and Bicycles Industry and Ready-Made Clothes Production Company, with average losses of (-0.0023) and (-0.0317), respectively. The detailed data is presented in Table (2).

Table 2: Return Rates of Sampled Companies Listed on the Iraq Stock Exchange

No.	Company Code	2024	2023	2022	2021	2020	Average
1	IMAP (Al-Mansour Pharmaceutical Industries)	0.0483	0.0575	-0.1097	0.2088	0.0691	0.0543
2	IMOS (Modern Sewing)	-0.0394	0.1509	-0.0233	-0.0511	0.1060	0.0385
3	ITTC (Iraqi Carpets and Furnishings)	0.0027	0.0073	-0.0033	0.1199	-0.0003	0.0279
4	IBPM (Baghdad Packaging Materials)	-0.1467	0.3618	0.0003	0.0002	0.0370	0.0622
5	IBSD (Baghdad Soft Drinks)	0.0095	0.0493	-0.0562	0.2160	0.2170	0.0404
6	IIDP (Iraqi Dates Manufacturing & Marketing)	0.3035	0.1404	0.0948	0.0081	-0.2134	0.0689
7	INCP (Iraqi Chemical & Plastic Industries)	0.0326	0.1995	-0.0522	0.0367	0.0549	0.0555
8	IKLV (Al-Kindi Veterinary Vaccines)	0.1803	0.0369	-0.0260	0.0465	-0.0339	0.0371
9	IMIB (Iraqi Metal & Bicycles Industry)	-0.0022	-0.0686	0.0957	0.0147	-0.0278	-0.0023
10	IRMC (Ready-Made Clothes Manufacturing)	-0.0773	-0.0326	-0.1620	0.0333	0.1020	-0.0317

Source: Prepared by the researcher based on Excel calculations.

Second: Risk Analysis of Sampled Companies Listed on the Iraq Stock Exchange

The analysis results presented in Table (3) indicate that the Iraqi Chemical & Plastic Industries Company recorded the highest risk level, reaching 37.8%. This is attributed to the significant fluctuation in its stock prices, particularly in 2023, when the stock price increased from 0.740 IQD at the beginning of the year to 1.750 IQD by the end of the year—representing a 42% increase. Following this, the Baghdad Packaging Materials Company recorded the second-highest risk level, with an average risk of 34.4%. Conversely, the lowest risk was recorded by the Iraqi Company for Carpets and Furnishings, with a risk level of 11.4%. Overall, the risk levels of the sampled companies fluctuated, as detailed in Table (3).

Table 3: Risk Ratios (Standard Deviation) of Sampled Companies Listed on the Iraq Stock Exchange

No.	Company Code	2024	2023	2022	2021	2020	Average
1	IMAP (Al-Mansour Pharmaceutical Industries)	0.065	0.201	0.268	0.235	0.138	0.229
2	IMOS (Modern Sewing)	0.083	0.161	0.031	0.095	0.461	0.225
3	ITTC (Iraqi Carpets and Furnishings)	0.075	0.080	0.043	0.174	0.077	0.114
4	IBPM (Baghdad Packaging Materials)	0.207	0.605	0.026	0.017	0.052	0.344
5	IBSD (Baghdad Soft Drinks)	0.019	0.123	0.117	0.140	0.108	0.143
6	IIDP (Iraqi Dates Manufacturing & Marketing)	0.448	0.182	0.051	0.025	0.014	0.239
7	INCP (Iraqi Chemical & Plastic Industries)	0.050	0.762	0.055	0.110	0.122	0.378
8	IKLV (Al-Kindi Veterinary Vaccines)	0.225	0.079	0.037	0.158	0.013	0.144
9	IMIB (Iraqi Metal & Bicycles Industry)	0.108	0.100	0.171	0.147	0.026	0.137
10	IRMC (Ready-Made Clothes Manufacturing)	0.028	0.139	0.223	0.140	0.128	0.175

Source: Prepared by the researcher based on Excel calculations.

Third: Analysis of the Coefficient of Variation and Beta of the Sampled Companies in the Iraq Stock Exchange

Table (4) presents the beta values and coefficient of variation for the sampled companies during the studied period. The highest beta value was recorded by Modern Sewing Company, reaching 0.866, indicating that its risk is lower than market risk, while the lowest beta value was observed in Baghdad Soft Drinks Company, at 0.127. Regarding the coefficient of variation, Modern Sewing Company had a value of approximately 6, meaning that for each unit of return, the company assumes 6 units of risk measured by the standard deviation. This suggests that Modern Sewing Company exhibits significantly higher risk compared to other companies, according to the coefficient of variation, as detailed in Table (4).

Table 4: Coefficient of Variation and Beta of the Sampled Companies in the Iraq Stock Exchange

No.	Company Code	Beta	Coefficient of Variation
1	IMAP (Al-Mansour Pharmaceutical Industries)	-0.220	4.217
2	IMOS (Modern Sewing)	0.866	5.844
3	ITTC (Iraqi Carpets and Furnishings)	0.151	4.086
4	IBPM (Baghdad Packaging Materials)	0.495	5.531
5	IBSD (Baghdad Soft Drinks)	0.127	3.540
6	IIDP (Iraqi Dates Manufacturing & Marketing)	-0.552	3.469
7	INCP (Iraqi Chemical & Plastic Industries)	-0.214	6.811
8	IKLV (Al-Kindi Veterinary Vaccines)	-0.434	3.881
9	IMIB (Iraqi Metal & Bicycles Industry)	0.218	-59.565
10	IRMC (Ready-Made Clothes Manufacturing)	-0.368	-5.521

Source: Prepared by the researcher based on Excel calculations.

Fourth: Analysis of Return and Risk Rates of the Iraq Stock Exchange Market Portfolio

The market index return was calculated using the holding period return formula for each quarter, while the market risk was measured using the standard deviation over the research period.

Table 5: Return and Risk Rates of the Iraq Stock Exchange Market Portfolio

Years	2020	2021	2022	2023	2024	Average
Iraq Stock Exchange Market Return	0.0467	0.0302	0.0130	0.1140	-0.0143	0.0403
Iraq Stock Exchange Market Risk	0.056	0.053	0.108	0.082	0.056	0.087

Source: Prepared by the researcher based on Excel calculations.

Table (5) presents the return series of the Iraq Stock Exchange market achieved during the studied period. The last column of the table shows that the average market return was 0.0403, while the risk levels fluctuated between 0.053 and 0.108.

Fifth: Constructing Investment Portfolios Using the Kataoka Model

All stocks of the sampled companies in the Iraq Stock Exchange during the studied period were nominated for portfolio construction based on the Kataoka model. The portfolio risk was determined by considering a 5% risk tolerance, meaning that at a 5% probability loss level, the value of (r_l) corresponds to (1.645). By multiplying the lowest standard deviation by (1.645) which represents the (r_l) value the risk-to-return ratio of the portfolio was obtained to maximize portfolio return. Using the Solver Parameters function, the portfolio returns and risks under the Kataoka model were calculated as follows:

Table 6: Portfolio Construction Results Based on the Kataoka Model for Sampled Companies Listed on the Iraq Stock Exchange

No.	Portfolio Constituent Companies	Optimal Weight	Return	Weight * Return
1	IMAP (Al-Mansour Pharmaceutical Industries)	0.168	0.054	0.0091
2	IMOS (Modern Sewing)	0.168	0.038	0.0065
3	ITTC (Iraqi Carpets and Furnishings)	0.229	0.028	0.0064
4	IBPM (Baghdad Packaging Materials)	0.070	0.062	0.0043
5	IBSD (Baghdad Soft Drinks)	0.041	0.040	0.0017
6	IIDP (Iraqi Dates Manufacturing & Marketing)	0.177	0.069	0.0122
7	INCP (Iraqi Chemical & Plastic Industries)	0.067	0.056	0.0037
8	IMIB (Iraqi Metal & Bicycles Industry)	0.080	-0.002	-0.0002
Total Weights		1		

Portfolio Metrics

- Portfolio Return: 0.04373
- Portfolio Standard Deviation: 0.08230
- Portfolio Beta: 0.18253
- Portfolio Systematic Risk: 0.00025
- Portfolio Unsystematic Risk: 0.00001
- Total Portfolio Risk: 0.00026
- Portfolio Coefficient of Variation (C.V): 1.88209

Source: Prepared by the researcher based on Solver Parameters program outputs.

Table (6) presents the results of portfolio construction based on the Kataoka model for the research sample in the Iraq Stock Exchange during the studied period. The portfolio, according to the Kataoka model, consisted of eight companies, as specified in Table (6). When comparing the results of the Kataoka model portfolio with the Iraq Stock Exchange market portfolio, the relative difference between the two portfolios' results becomes evident. The Kataoka model portfolio outperformed the market portfolio in terms of returns, achieving an average return of (0.0437), whereas the market portfolio recorded a return of (0.0403). Meanwhile, the standard deviation of the Kataoka model portfolio was (0.0823), which is lower than the market portfolio's risk level of (0.087). In terms of the trade-off between return and risk, the Kataoka model portfolio demonstrated superior performance compared to the market portfolio, as evidenced by the Sharpe ratio, where the Kataoka model portfolio achieved a value of (0.531), while the market portfolio recorded (0.463). As a result, the null hypothesis was rejected, and the alternative hypothesis was accepted, indicating that "the portfolio based on the Kataoka model achieves better performance than the market portfolio in the trade-off between return and risk."

Chapter Four: Conclusions and Recommendations

Conclusions

1. The results of portfolio performance indicate that the portfolio constructed based on the Kataoka model is superior in terms of the trade-off between return and risk compared to the market portfolio presented in the study.
2. The success of an investment portfolio depends on the model upon which it is constructed, along with the principles, policies, and strategies adopted by the investor to make investment decisions that reflect portfolio quality.
3. Investors typically tend to avoid risk by implementing diversification strategies in the portfolio's stocks and assets, aiming to achieve the highest possible return while being exposed to minimal and measurable risks.

Second: Recommendations

1. Adopting the findings of this research, as it provides a comprehensive overview of the return and risk levels for the sampled companies listed on the Iraq Stock Exchange, to guide investment decisions, construct securities portfolios, and evaluate them effectively.
2. Investors should utilize the model employed in this study when forming their investment portfolios, rather than diversifying randomly, as doing so may compromise the portfolio's potential to achieve the lowest possible risk while maximizing benefits.
3. The market administration should establish a library containing literature and studies related to the Iraq Stock Exchange, financial market management, and portfolio management, while continuously enriching it with the latest publications. Additionally, intensive training programs should be organized for the Financial Market Authority on modern models and principles in portfolio construction and evaluation.

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