**Journal of Information Systems Engineering and Management**
2025, 10(44s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

**Research Article**

# Application of Artificial Neural Networks (ANN) in Forecasting the Dubai Financial Market Index

Sarah abdulkareem AL-Naseri [1], Chakroun Raida [2]
[1] *PhD student, University of Sousse, Institute of Higher Commercial Studies of Sousse IHEC*
[2]*Affiliation Associate Professor-University of Carthage, IHEC, Department of Accounting, Tunisia*
*University of Manouba, ISCAE, LIGUE LR99ES24, Tunisia*

**ARTICLE INFO**

Received: 28 Dec 2024

Revised: 18 Feb 2025

Accepted: 26 Feb 2025

**ABSTRACT**

Accurate forecasting of the Dubai Financial Market (DFM) index constitutes a strategic tool for supporting investors' and portfolio managers' decision-making processes, given the volatile and nonlinear nature of financial markets.

This study aims to evaluate the efficiency of neural network models in forecasting the daily closing values of the DFM index, based on historical financial data.

MATLAB R2023a was utilized to test several neural predictive models with varying architectures, in order to identify the most optimal model in terms of accuracy and predictive performance. The best-performing model employed a Logsig activation function in the hidden layer and a linear function in the output layer.

The results of the selected model demonstrated high accuracy, with a Mean Squared Error (MSE) of approximately 97.0, a Mean Absolute Error (MAE) of 7.68, a Mean Absolute Percentage Error (MAPE) of 0.21, and a Coefficient of Determination ($R^2$) of around 0.9989. These metrics reflect the model's strong capability in capturing the underlying relationships between variables.

The findings suggest that neural network models are effective in analyzing financial time series and extracting complex patterns, thereby enhancing their value as decision support tools in dynamic market environments.

**Keywords:** Artificial Neural Networks, Dubai Financial Market, MATLAB.

## INTRODUCTION

Accurate forecasting of stock market indices is pivotal for investors aiming to optimize returns. Traditional statistical models often fall short in capturing the nonlinear and volatile nature of financial markets. Artificial Neural Networks (ANN), inspired by biological neural systems, have emerged as powerful tools for modeling complex patterns in time series data. This study focuses on applying ANN to forecast the Dubai Financial Market (DFM) index, evaluating the model's performance and potential benefits for financial decision-making.

In this context, machine learning techniques have emerged as promising tools for market analysis and forecasting, due to their ability to process large volumes of data and uncover hidden patterns that traditional methods may overlook. Among these techniques, Artificial Neural Networks (ANNs) have demonstrated notable efficiency in forecasting stock price movements, owing to their high flexibility in modeling nonlinear relationships.

Based on this significance, the current study aims to employ the ANN algorithm to forecast the Dubai Financial Market (DFM) index by analyzing daily index data over the period 2020–2023. The study seeks to evaluate the model's predictive performance and its ability to capture future trends, thereby contributing to more informed investment decisions and enhancing market efficiency.

## OBJECTIVES

This study aims to achieve the following key objectives:

Journal of Information Systems Engineering and Management
2025, 10(44s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

1- To analyze the concept of stock price forecasting and its importance in supporting investment decision-making .

2- To investigate and evaluate the effectiveness of the Artificial Neural Network algorithm in predicting stock market movements .

3- To provide practical results and recommendations for market participants regarding the use of advanced forecasting techniques in analyzing market trends.

## METHODS

The study adopts a "descriptive-analytical methodology". The descriptive part involves reviewing relevant literature. The analytical part focuses on processing historical financial data from the Dubai Financial Market using the ANN algorithm, in order to assess its predictive performance and accuracy.

Daily closing prices of the DFM index (2020–2023) were analyzed using MATLAB R2023a to develop and evaluate various ANN models with different architectures. Model performance was assessed through MSE, MAE, MAPE, and $R^2$ metrics.

### 1- Research Problem

Forecasting stock prices represents a significant challenge due to the dynamic nature of financial markets and the complex interplay of various economic, political, and social factors. These fluctuations contribute to the difficulty of accurately predicting market movements. Since stock prices follow a time series pattern, forecasting models must account for the temporal relationships between past and future values.

Accordingly, this study seeks to answer the following research question :

Can Artificial Neural Networks (ANNs) accurately forecast the Dubai Financial Market (DFM) index?

### 2- Research Hypotheses

Scientific hypotheses form the core of empirical research by guiding the investigation of relationships among variables. In the context of this study, which explores the predictive power of ANNs for the DFM index, the following hypotheses are formulated:

- Null Hypothesis ($H_0$): There is no statistically significant relationship between the application of the Artificial Neural Network algorithm and the accuracy of forecasting the DFM index .

- Alternative Hypothesis ($H_1$): There is a statistically significant relationship between the application of the Artificial Neural Network algorithm and the accuracy of forecasting the DFM index.

### 3- Spatial and Temporal Boundaries

- Spatial Scope: The study is focused on the Dubai Financial Market (DFM), as a representative emerging financial market in the Arab region .

- Temporal Scope: The study covers the period from 2020 to 2023, a timeframe marked by significant volatility in global financial markets due to various economic developments, which enhances the analytical relevance of the results

### Theoretical Framework of the Study

### 1-Forecasting Concept

Forecasting is both an art and a science aimed at anticipating future events. It is considered an art because managerial experience, intuition, and judgment play a crucial role in selecting the appropriate forecasting method, which enhances accuracy and reduces bias (Najm & Aboud, 2015, p. 69).

### 2- Stock Market Indices

An index is defined as a sample of stocks from several companies representing the traded shares in the market. The price movement of these stocks reflects the future trends of prices in the market (Hindi, 2002, p. 566).

Journal of Information Systems Engineering and Management
2025, 10(44s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

The index measures the prices of securities in the market, based on a selected sample of stocks and sectors actively traded in capital markets. This sample is chosen in a way that enables the index to accurately reflect the market's condition (Abdel Qader, 2009, p. 193).

### 3- Artificial Neural Networks (ANNs)

Artificial Neural Networks (ANNs), also referred to as simulated neural networks (SNNs), are computational systems inspired by the biological neural networks of the brain. They consist of interconnected artificial neurons designed to mimic the brain's ability to process and interpret information (Raichik, Nathaniel & Devereux, 1982, 103(2): 202-209).

Generally, ANNs are structured in layers—input, hidden, and output layers—each performing simple tasks. The network's overall performance results from the interaction among these neurons. ANNs are particularly effective in capturing complex, nonlinear patterns in data, providing high predictive accuracy. However, they require large datasets for effective training and may be complex in design and interpretation.

### 4- Dubai Financial Market General Index (DFMGI)

The DFM General Index was officially launched on December 3, 2006, to simulate the performance of companies listed on the Dubai Financial Market (DFMGI). It is considered a vital measure of Dubai stocks and is closely followed by investors and the media. The index's base date is December 31, 2003 (Dubai Financial Market, 2018).

DFMGI is a crucial indicator reflecting the performance of listed stocks in Dubai and tracking market trends. It comprises a variety of companies across economic sectors and is calculated based on the market capitalization of listed stocks. DFMGI serves as a key tool for investors and financial analysts to monitor market performance and formulate investment strategies.

### Application of the Artificial Neural Network Algorithm

Accurate forecasting of the stock market is of great importance to investors, as the demand for tools that assist in predicting stock trends is continuously increasing. This is due to the direct impact accurate predictions have on profit generation— the more precise the results, the greater the potential for profit. Market trends are influenced by various factors, including political, economic, and social elements. As such, accurately forecasting stock market returns is a highly challenging task due to the volatile and nonlinear nature of financial markets.

### Practical Implementation of the Proposed System

The data was processed and executed using the MATLAB programming language, version R2023. MATLAB is a modern, high-performance programming language and a digital computing environment developed by MathWorks. It integrates computing, visualization, and programming environments, enabling tasks such as computer-aided design, matrix manipulation, function and data plotting, algorithm implementation, user interface creation, and interaction with programs written in other languages.

Additionally, MATLAB includes advanced data structures, built-in editing and debugging tools, and supports object-oriented programming. These features make MATLAB an excellent tool for educational and research purposes in both industry and academia.

A wide variety of MATLAB's integrated and custom-developed tools were utilized to develop the software system for forecasting the Dubai Financial Market index based on daily stock prices (closing price).

### Performance of the Artificial Neural Network (ANN) Model

Table (1) presents the results of applying the Artificial Neural Network (ANN) algorithm to forecast the Dubai Financial Market (DFM) index during the testing period. For models employing the Tansig activation function in the hidden layer, the best performance was observed when using the Linear activation function in the output layer, particularly with a configuration of 12 hidden neurons , achieving the following metrics :

MSE = 195.0, MAE = 10.85, MAPE = 0.282 .

**Journal of Information Systems Engineering and Management**
2025, 10(44s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

**Research Article**

However, other configurations—such as Tansig-Tansig and Tansig-Logsig—yielded significantly poorer results. For example, the combination Tansig-Logsig with 12 hidden neurons resulted in a Mean Squared Error (MSE) exceeding one million ( MSE = 1,159,607), reflecting the sensitivity of model performance to activation function selection.

In the case of using the Logsig activation function in the hidden layer, the optimal performance was achieved when paired with the Linear function in the output layer, especially with 4 hidden neurons , producing the following results :

MSE = 97.0, MAE = 7.68, MAPE = 0.21, and a high R-squared value ($R^2$) = 0.9989 .

Furthermore, the Logsig-Linear configurations consistently demonstrated high predictive accuracy, with $R^2$ values exceeding 0.99 across different model structures.

Regarding the use of the Linear activation function in the hidden layer, the models that also employed the Linear function in the output layer provided the most robust performance across the board, regardless of the number of hidden neurons. These configurations consistently delivered very low MSE values (e.g., MSE = 90.7) and exceptionally high $R^2$ values (up to 0.9989) , underscoring the suitability of the Linear-Linear architecture for forecasting the DFM index.

Table (1): ANN Algorithm Performance Results in Forecasting the DFM Index During the Testing Period

| No. | HLTF | OLTF | HLS | MSE | MAE | MAPE | $R^2$ |
|---|---|---|---|---|---|---|---|
| 1 | Tansig | Tansig | 4 | 2894834 | 1358.7843 | 34.5163 | 0.8692 |
| 2 | Tansig | Tansig | 8 | 84682.6 | 271.3003 | 7.3113 | 0.0000 |
| 3 | Tansig | Tansig | 12 | 43084.2 | 144.5472 | 3.5944 | 0.8911 |
| 4 | Tansig | Tansig | 16 | 43095.3 | 144.9807 | 3.6068 | 0.8883 |
| 5 | Tansig | Tansig | 20 | 84682.6 | 271.3003 | 7.3113 | 0.0000 |
| 6 | Tansig | Logsig | 4 | 43105.0 | 144.9295 | 3.6051 | 0.8934 |
| 7 | Tansig | Logsig | 8 | 43090.3 | 144.6156 | 3.5963 | 0.8921 |
| 8 | Tansig | Logsig | 12 | 1159607 | 1036.8443 | 27.2440 | 0.0000 |
| 9 | Tansig | Logsig | 16 | 43087.8 | 144.8240 | 3.6026 | 0.8878 |
| 10 | Tansig | Logsig | 20 | 84682.6 | 271.3003 | 7.3113 | 0.0000 |
| 11 | Tansig | Linear | 4 | 598970635 | 563497.5 | 14097.35 | 0.8679 |
| 12 | Tansig | Linear | 8 | 10107.3 | 70.6901 | 1.7639 | 0.9836 |
| 13 | Tansig | Linear | 12 | 195.0 | 10.8525 | 0.2844 | 0.9988 |
| 14 | Tansig | Linear | 16 | 115397525 | 7802.54 | 195.108 | 0.8617 |
| 15 | Tansig | Linear | 20 | 540924501 | 14559.84 | 358.942 | 0.7372 |
| 16 | Logsig | Tansig | 4 | 2698809 | 1267.4642 | 32.0962 | 0.8515 |
| 17 | Logsig | Tansig | 8 | 43092.2 | 144.7025 | 3.5988 | 0.8922 |
| 18 | Logsig | Tansig | 12 | 84682.6 | 271.3003 | 7.3113 | 0.0000 |
| 19 | Logsig | Tansig | 16 | 44018.9 | 146.9961 | 3.6574 | 0.8860 |
| 20 | Logsig | Tansig | 20 | 43170.2 | 145.9949 | 3.6346 | 0.8887 |
| 21 | Logsig | Logsig | 4 | 43096.9 | 144.7541 | 3.6001 | 0.8927 |
| 22 | Logsig | Logsig | 8 | 43080.6 | 144.4670 | 3.5923 | 0.8920 |
| 23 | Logsig | Logsig | 12 | 43100.9 | 145.2152 | 3.6135 | 0.8862 |
| 24 | Logsig | Logsig | 16 | 55654.4 | 164.7010 | 4.0978 | 0.8120 |

**Journal of Information Systems Engineering and Management**
2025, 10(44s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

**Research Article**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 25 | Logsig | Logsig | 20 | 43090.1 | 144.6594 | 3.5976 | 0.8916 |
| 26 | Logsig | Linear | 4 | 97.0 | 7.6804 | 0.2062 | 0.9989 |
| 27 | Logsig | Linear | 8 | 4899.8 | 49.3474 | 1.2341 | 0.9911 |
| 28 | Logsig | Linear | 12 | 1090.7 | 22.5668 | 0.5724 | 0.9952 |
| 29 | Logsig | Linear | 16 | 3156.4 | 30.5879 | 0.7729 | 0.9745 |
| 30 | Logsig | Linear | 20 | 37924638 | 3851.2560 | 94.993 | 0.7055 |
| 31 | Linear | Tansig | 4 | 77383.1 | 216.9696 | 5.4672 | 0.9734 |
| 32 | Linear | Tansig | 8 | 77383.1 | 216.9696 | 5.4672 | 0.9734 |
| 33 | Linear | Tansig | 12 | 77383.1 | 216.9696 | 5.4672 | 0.9734 |
| 34 | Linear | Tansig | 16 | 77383.1 | 216.9696 | 5.4672 | 0.9734 |
| 35 | Linear | Tansig | 20 | 77383.1 | 216.9696 | 5.4672 | 0.9734 |
| 36 | Linear | Logsig | 4 | 46927.2 | 165.4589 | 4.1719 | 0.8780 |
| 37 | Linear | Logsig | 8 | 46927.2 | 165.4589 | 4.1719 | 0.8780 |
| 38 | Linear | Logsig | 12 | 46927.2 | 165.4589 | 4.1719 | 0.8780 |
| 39 | Linear | Logsig | 16 | 46927.2 | 165.4589 | 4.1719 | 0.8780 |
| 40 | Linear | Logsig | 20 | 46927.2 | 165.4589 | 4.1719 | 0.8780 |
| **41** | **Linear** | **Linear** | **4** | **90.7** | **7.2595** | **0.1955** | **0.9989** |
| 42 | Linear | Linear | 8 | 90.7 | 7.2595 | 0.1955 | 0.9989 |
| 43 | Linear | Linear | 12 | 90.7 | 7.2595 | 0.1955 | 0.9989 |
| 44 | Linear | Linear | 16 | 90.7 | 7.2595 | 0.1955 | 0.9989 |
| 45 | Linear | Linear | 20 | 90.7 | 7.2595 | 0.1955 | 0.9989 |

Figure (1) illustrates the observed versus predicted values of the Dubai Financial Market (DFM) stock index during the testing period using the ANN algorithm. The close alignment between these values indicates that the model demonstrates a very strong performance in capturing the trends and fluctuations of the stock market. The slight differences between the observed and predicted values further confirm the model's reliability in forecasting stock market movements, making it a valuable tool for financial forecasting. The numerical values of the observed and predicted time series of the DFM stock index during the testing period using the ANN algorithm.

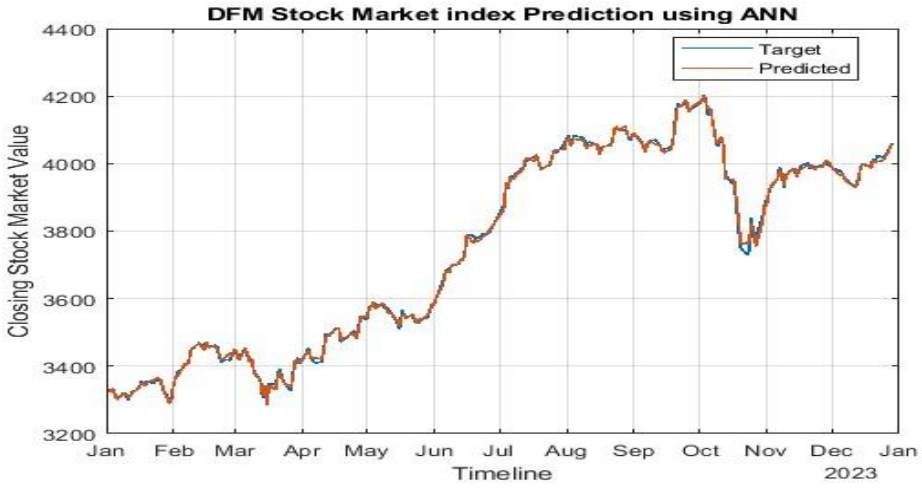


Figure (1): Time Series of the Observed vs. Predicted Values of the DFM Stock Index During the Testing Period Using the ANN Algorithm.

**Journal of Information Systems Engineering and Management**
2025, 10(44s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

**Research Article**

## RESULTS

The ANN model with a Logsig activation function in the hidden layer and a Linear function in the output layer demonstrated superior performance, achieving MSE = 97.0, MAE = 7.68, MAPE = 0.21, and $R^2$ = 0.9989. Other configurations yielded higher error rates and lower predictive accuracy.

## DISCUSSION

The findings highlight the ANN model's capability to effectively forecast the DFM index, capturing the intricate nonlinear relationships inherent in financial time series data. The high $R^2$ value indicates a strong correlation between predicted and actual values, suggesting the model's reliability for practical applications in financial forecasting.

### Conclusions

1- Effectiveness of Artificial Neural Networks (ANN):

The findings of the study indicate that the Artificial Neural Network algorithm is capable of accurately forecasting the Dubai Financial Market (DFM) index. This is particularly evident when appropriate activation functions and the optimal number of hidden neurons are selected, reflecting the model's ability to capture complex and nonlinear financial patterns.

2- Model Performance During the Testing Period :

The ANN model demonstrated strong predictive performance during the testing phase, with low statistical error indicators such as Mean Squared Error (MSE) and Mean Absolute Percentage Error (MAPE), while the coefficient of determination ($R^2$) exceeded 0.99 in certain configurations—indicating a strong fit between actual and predicted values.

3- Importance of Activation Functions and Network Configuration :

The results highlight the critical role of selecting proper activation functions and hidden layer architecture. For instance, the (Logsig–Linear) configuration with four hidden neurons achieved superior results, outperforming other structures with less predictive accuracy.

4- Practical Applicability :

The study supports the use of ANN as a reliable quantitative tool for financial forecasting. It demonstrates that such models can assist investors and portfolio managers in developing proactive strategies based on predictive analytics rather than relying solely on historical market behavior

### Recommendations

1- Adoption of Computational Intelligence in Financial Forecasting :

The study recommends the adoption of Artificial Neural Networks in emerging markets, such as the Dubai Financial Market, as they offer robust capabilities in handling nonlinear relationships and sudden fluctuations in stock prices.

2- Enhancing Digital Infrastructure in Financial Institutions :

Financial institutions are advised to upgrade their technological infrastructure to accommodate machine learning tools and algorithms, while also investing in specialized personnel capable of designing and training predictive models using real-time market data.

3- Diversification of Forecasting Models :

It is suggested that reliance should not be placed on a single model. A hybrid approach that combines ANN with traditional statistical models (e.g., ARIMA or GARCH) can provide more reliable and flexible forecasting results under volatile market conditions.

**Journal of Information Systems Engineering and Management**
2025, 10(44s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

**Research Article**

4- Future Research Directions :

Future studies are encouraged to expand the scope of research to include other financial indices and emerging markets, as well as assess ANN model performance during economic crises or unexpected events to evaluate their adaptability under unstable conditions

## REFRENCES

[1] Awais MM, et al., 2019. Immunomodulatory and ameliorative effects of Lactobacillus and Saccharomyces based probiotics on pathological effects of eimeriasis in broilers. Microbial Pathogenesis, 126: 101-108.
[2] Chen AS, Leung MT, Daouk H, 2003. Application of neural networks to an emerging financial market: Forecasting and trading the Taiwan Stock Index. Computers & Operations Research, 30(6): 901–923.
[3] Gujarati DN, Porter DC, 2009. Basic Econometrics, 5th ed. McGraw-Hill Education.
[4] Huang W, Nakamori Y, Wang SY, 2005. Forecasting stock market movement direction with support vector machine. Computers & Operations Research, 32(10): 2513–2522.
[5] Khashei M, Bijari M, 2010. An artificial neural network (p, d, q) model for time series forecasting. Expert Systems with Applications, 37(1): 479–489.
[6] MathWorks Inc., 2023. MATLAB R2023a Documentation. https://www.mathworks.com/help/
[7] Njam, A, 2015. Economics of Business. Dar Al-Masirah Publishing.
[8] Hindi, A, 2002. Financial Markets: Analysis and Decisions. New University House.
[9] Dubai Financial Market, 2018. DFM General Index Rulebook. https://www.dfm.ae