

Investigation And Forecasting Of Tehran Stock Exchange Indices According To Macroeconomic Variables: Using Artificial Neural Network With Multilayer Perceptron (Mlp)

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Abstract

Background: Due to the key impact of macroeconomic variables on stock market indices, their nonlinear and nonparametric behavior, investors, financial managers and economic actors are in macro risk conditions. Therefore, predicting the volatility of indicators has always been one of the most controversial issues in the field of financial issues and is very important.

Method: In order to predict the fluctuation of these indices in Tehran Stock Exchange and the impact of macroeconomic variables such as exchange and inflation rates, gold and oil prices, export and import volumes, relevant statistical data were extracted during 2014-2018. Then, stock indices were forecasted during the mentioned period. In this study, artificial neural network with multilayer perceptron (MLP) was used.

Results: The results show that macroeconomic variables affect the Tehran Stock Exchange index. Neural networks have the ability to predict the stock market index in time periods with an appropriate error rate.

Keywords; Tehran Stock Exchange Index, Multilayer Perceptron, Neural Networks, Inflation Rate, Gold Price, Exchange Rate, Exports and Imports.

Introduction

While the relationship between stock market returns and macroeconomic variables has been fully explored. There is a gap in the research literature when examining the relationship between different sector indicators and different macroeconomic variables. This study examines how specific macroeconomic variables affect different stock market segments. The results show important insights for private investors, pension funds and governments. This is because long-term investors often make their decision to invest in stocks based on macroeconomic variables (Erfan M, 2020).

Findings show that inflation has a greater effect and is inversely related to stock market returns. In this case, correction is needed to ensure that inflation is kept at a low level, as the results can be instrumental in boosting the capital market (Jamaludin, 2017).

Given these findings, we argue that the interaction between index of industrial production, inflation, exchange rate, and interest rate have a significant role in stock prices. Hence, GDP economic growth (index of industrial production (IIP)) positively impact on stock returns, because of stock returns as any increase favorable effects on demand. Increasing inflation rate negatively impact on stocks returns, because of inflation rate as increases input cost. Increasing interest rate many ways to attract the investors to invest in stocks markets, it will give a required rate of returns. Both interest rate and inflation rate are causes raise in financial costs. Moreover, a depreciation (Increasing) in the exchange rate can be favorable for an economy. Thus, the exchange rate can positively impact on stock returns (Chandrashekar, 2018).

The findings of a study suggest that exchange rate and interest rates have a significant impact on the Islamic stock market. The implications of the study are that exchange rates and interest rates should be controlled so as to improve the performance of the Islamic stock market (Habib, 2017).

This study was conducted to predict the Tehran Stock Exchange index with respect to the impact of macroeconomic variables and using an artificial neural network with a multilayer perceptron (MLP) structure.

Methods

The present research is a descriptive-inferential type study which is conducted with an applied purpose and quantitatively as follows:

The method of data collection is field based and the research period is from 2014 to 2017. The information on macroeconomic variables and the stock exchange indices has been collected from the Tehran Stock Exchange

and the statistical center of Iran (sci) and some reputable websites. After collecting the required data, all of them were coded and analyzed by Matlab R 2018a software. Then, according to their classification and processing, the final model was extracted. Finally, a comparison was made between the results of the model and the actual results.

To evaluate the predictive power, various criteria were used, including coefficient of determination (R^2), mean squared error (MSE). These criteria can be shown as follows:

$$MSE = \frac{\sum_{i=1}^n e^2}{n}$$

$$R^2 = 1 - NMSE$$

While in this equation, n represents the number of predictions and their error, which is obtained from the difference between the predicted number and the actual values.

Modeling and forecasting

The available information is related to the years 2014-2017, which has been collected from the websites of the Central Bank of the Islamic Republic of Iran, the Tehran Stock Exchange Organization and the systems related to the price of gold. In these cases, Excel and MatlabR2018a software were used to analyze the data and determine the model.

In this research, multilayer perceptron neural networks (MLP) with error post-diffusion learning algorithm have been used. Exchange rates, inflation, exports, imports, gold and oil prices and the total index of the Tehran stock exchange were used as input variables. For data analysis, two models were considered. In the first model, with the entry of data related to macroeconomic variables, the stock index, the possibility and the degree of correlation between input-dependent variables and independent variables were examined. Sensitivity analysis was performed for each of the input variables based on the trained model.

The feed forward neural network was created with a 6-5-1-1 design. This network has six input layers for 6 independent variables and a single-neuron output layer per Tehran Stock Exchange indices. Hidden layers also have 110 neurons with sigmoid conversion functions. The statistical coefficients R and R^2 as well as the characteristics of the feed forward neural network are shown in Table 1.

Table 1- The feed forward neural network characteristics

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Final report : estimate Value by neural network
=====
|-----|
| Neural network | valume : type |
|-----|
| Network type   | feedforwardnet_trainlm |
| hidden Layer Size | 5 |
| Max Epochs     | 110 |
| No. of input   | 6 |
|-----|
|-----|
|-----|
| Static Info | valume |
|-----|
| R : Train | 0.99961 |
| R2 : Train | 0.99922 |
|-----|
```

The proximity of the coefficient of determination to the number "one" indicates a strong correlation between macroeconomic variables and the Tehran Stock Exchange index during the 2014-2017 period. Also, the proximity of MSE to "zero" (MSE = 0.0279) indicates a lower error rate. The model indicator for the output layer of sigmoid conversion function and the model output is shown in Figure 1.



Figure 1- Model output

In the second model, with the entry of macroeconomic variables and the stock index during 2017-2014, after testing the estimated index model by the network with the model design, the number of hidden layers is 2, 70 neurons and 6 estimated inputs. Thus, we achieved the main goal of the research. Statistical coefficients R and R^2 as well as the characteristics of the feed neural network are shown in Table 2.

Table 2- The feed forward neural network characteristics

Final report : estimate Value by neural network		
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Neural network	value	type

Network type	feedforwardnet_trainlm	
hidden Layer Size	5	3
Max Epochs	70	
No. of input	6	
No. of train	35 : 79.5455 %	
=====		

Static Info	value	

R : Train	0.99937	
R2 : Train	0.99874	

R : Test	0.97559	
R2 : Test	0.94348	

The proximity of the test determination coefficient to the number one indicates the high predictive power of the model. Also, the fact that MSE is close to zero (MSE=0.2377) indicates a lower error rate. The model indicator for the output layer of sigmoid conversion function and the model output is shown in Figure 2.

Noteworthy in the diagrams is the explicit discrepancy between the real total index and the total index estimated by the multilayer perceptron artificial neural network at the end of 2016. Noteworthy in the above diagrams is the explicit discrepancy between the real total index and the total index estimated by the multilayer perceptron artificial neural network at the end of 2016.

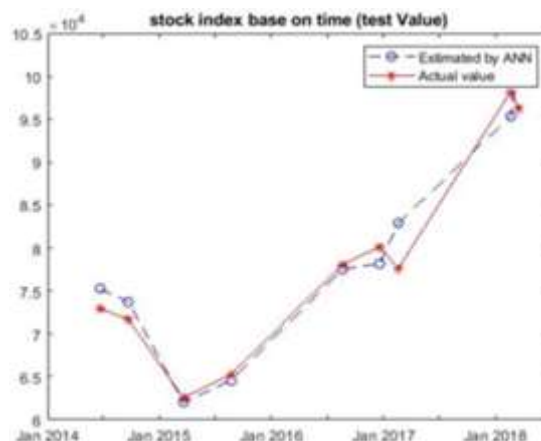


Figure 2- Model output

Discussion and Conclusion

Chian et al. (1996) used an error retransmission network to forecast the net asset prices of investment firms at the end of the year. They compared network data and the results of their work with the results of traditional econometric techniques and found that in neural networks, when data is scarce, it performs significantly better than regression methods.

Garliasgas (1999) predicted the stock market time series using a neural network computational algorithm related to the kernel function and the back propagated error. He concluded that the prediction of financial time series by neural networks is better than classical statistical models and other models that are consistent with the results of the present study.

According to the analysis of the proposed model, we conclude that the error criteria of the artificial neural network method are very small compared to other methods and have a better performance than them and can significantly reduce the prediction error.

By emphasizing the general purpose of the research and the results of similar research, it can be seen that macroeconomic variables affect the stock market index. Therefore, having the values of these variables, it is possible to estimate the total index of the stock exchange. Also, considering that the total index of Tehran Stock Exchange is also considered as a tool to understand the economic situation of the country, therefore, by reflecting on its fluctuations, it is possible to take the necessary measures to adjust for sudden shocks. On a micro scale, this index is considered as an investor decision-making tool. Especially, when the stock market is not very efficient.

Given that the forecast of the total index in this study (except in the period from early to mid-2016) shows an acceptable correlation with the real index, this model can be divided into two periods before and after "Non-compliance" period. The reason for the discrepancies may be due to several factors such as changes in macro policies or managers of the Tehran Stock Exchange, initial public offering of shares by book building method, trading authority, and other factors that have a greater impact on the stock index than macroeconomic variables.

However, it is clear that no phenomenon can be judged or even predicted in one dimension. Therefore, the influence of other effective variables on this index can be considered. In view of what has been said, the economic authorities, and in particular, the managers of the Tehran Stock Exchange, are advised to take the necessary measures to maintain balance and stability and the importance of the role of macroeconomic variables in the overall index. Also, since various factors affect the index, it is necessary to control the variables as much as possible so that they can attract the requirements of the stock exchange and especially the trust of investors. In this way, the development, dynamism and progress of the stock exchange can be achieved.

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