A Model for Prediction of Bahar Azadi Coin Price via Neural Network

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ABSTRACT: Investment in gold is one of the interesting ways of earning money in Iran. Therefore, access to gold price is a main factor for investors. In recent years, easy access to gold price has faced withsome restrictions because of its high volatility. There are numerous means of gold price prediction. Recently, artificial intelligence and Neural Network have attracted much attention among scientific communities due to their high accuracy in price prediction. In this paper, prices of Iranian Bahar-e-Azadi gold coin have been extracted in a period of one year.After identifying the effective factors, influence of each factor has been acquired. Afterwards,theprice of gold coin has been predicted with the Neural Network method and finally, the accuracy of this procedure has been obtained.

KEYWORDS: Investment, High volatility, Gold coin, Neural Network, Price prediction.

1 INTRODUCTION

Bahar Azadi coin is one of the legal gold coinages inthe Islamic Republic of Iran. Bahar Azadi coins are minted in two types and various weights. These coins are stamped in Central Bank mint of Iran and distributed by agent banks or authorized exchanges and sold as retail or wholesale every year.

Gold coins are used as an investment asset to preserve money present value. These coins are an important part of investments and savings amongthe Iranian people. Due to the considerable role of gold coin as investing asset, banks hold a part of their investment and liquidity as coins to obtain bankroll and more secure investments. Investing gold coins are less risky because of their intrinsic value. Comparing to other assets like real estate, gold coin has more liquidity and can be sold in every occasion. There are investors in gold coin bazaars of Iran who trade in large amounts of gold coins considering gold price fluctuations in Iran and abroad. These Investments generally cause return between 30 and 50 percent annually. Gold coins are traded as retail and wholesale. Considering the many applications of gold coin, consumption and trading of it has a high frequency, multiplicity and high reproducibility. Accordingly, gold coin consumption and trading cash volume are more than many main staples even at peak times. Beside traditional ways of trading in bazaar, gold coin futures are traded in the Iran Commodity Exchange.

Due to the importance of gold coin price forecasting gold coin price has a considerable role in an investment. Various methods are presented for the gold coin price prediction. Generally the most used methods are Statistic methods such as regression, time series, autoregressive and moving average smooth development.

In recent decades by developing metaheuristic methods and artificial intelligence methods, Neural Network and fuzzy logic methods have gained more attention.

In this paper a Neural Network method is presented to predict gold coin price. Several factors are effective on gold coin price. Factors with considerable impact over gold coin prices, which have been studied in this paper are prices of gold, world prices of crude oil, exchange rate, dollar rate, Iran gold coin prices and Inflation rate of Iran.

For predicting gold coin price with Neural Network method, alldata related to effective factors are gathered throughout a year. Gold coin price is forecasted by training a Multi-layer Perceptron Neural Network (MLP) with the data. Finally model accuracy has been analyzed.

2   LITERATURE REVIEW

Many researchers have studiedeffective factorson gold price and made models to predict it. Tully and Lucey have studied the effect of macro-economic variables on current price and future price of gold with GARCH models [1]. They forecasted gold price with a GARCH model of future price, cash indexes and a few other factors. Blose had studied the effect of expected inflation rate on gold price volatility [2]. He considered the CPI index as an indicator of inflation variable and demonstrated that the changes in CPI leads the investors to bond exchanges as they can't predict gold price while there is inflation. Ismail et al estimated gold price with multiple regression [3]. Batten et al. studied the effect of important economic factors, economical periods, money environment and financial markets on price of valuable metals like gold, silver, platinum and palladium and indicated they are considerably effective [4]. Shafiee and Topal presented a research on long term trend of gold price and its relation with two major factors: oil price and inflation [5]. Using historical gold price data for 40 years a long term trend reverting jump and dip diffusion model was used to predict gold price for the next 10 years, which indicated that there is a direct relationship between gold price and oil price but there is no noticeable relation between USA inflation and gold price. Zhang and Wei reported that the effect of oil on gold priceis prevailing [6] Ali khan proposed a model for forecasting gold price with Box Jenkins approach [7].

According to developments in artificial intelligence in recent years,many studies have used this method toimprove predictioncapability. Ghezelbash presented a model using gold price and stock index volatility withNeural Network [8]. Yuan predicted gold coin price by combining Neural Network and GA algorithm [9]. Chai et al. utilized Neural Network in stock index prediction [10]. They merged Neural Network and Gari theory to acquire more precise prediction using less input data. They used Gari theory output data as input data for a Neural Networkto increase accuracy. Malliaris et al. introduced a study about comparing time series and Neural Network to prognosticate gold, oil and euro price [11]. Shaikh and Zahid predicted S&P future index with Neural Network method [12]. Changa et al proposed a joint model of Neural Network, fuzzy logic and autoregressiveapproaches to predict TAIEX stock index [13]. Grudnitski forecasted S&P Index and gold future price index utilizing Neural Network [14].

A few papers studied gold coin price forecasting in Iran,but there is not any complete paper on forecasting Bahar Azadi coin price by using Neural Network. The presented paper could contribute to this fact.

3   RESEARCH METHODOLOGY

3.1   NEURAL NETWORK

The Neural Network is an information processing system inspired from human brain. Information is processed with large number of minuscule elements which are interconnected and work parallel to solve a problem. By use of computer programming an information structure is designed which can act like neurons. Connecting the neurons leads to a network that can be taught.

In this Neural Network neurons have two modes: active (on or 1), inactive (off or 2) and every synapse has a weight. Positive weighted synapses excite the next inactive nodes and negative weighted synapses inactive the next connected node (if it was active). A Neural Networkconsists of layer components and weights. TheNetwork behavior depends on the relationship between components. There are three different kinds of layers in a Neural Network:

- input layers: receiving the raw data that is fed into the grid.
- Hidden layers: Function of these layers is defined by the connection weights between them and inputs. A weight between hidden layers and input data determines when a hidden layer must be activated.
- Output layers: Function of these layers is depended onhidden unit activity and connection weights between hidden and output units.
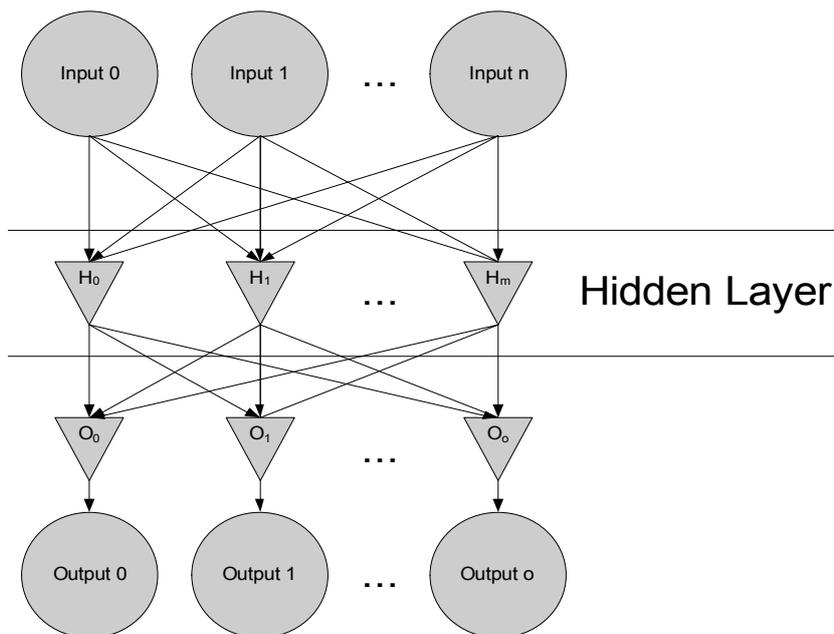
Figure 1 is an example of a Neural Network.

Fig. 1.   An overview of Neural Network

Between multi-layer and single layer networks, single layers in which all layers are connected to one layer are commonly used due to their higher calculating potential than multi-layer networks. In multi-layer networks units are numbered by layers. Each two layers of a network are connected with weights. Feed-forward is one of the different modes of connections in Neural Networks, which is more commonly used. In a feed-forward Neural Network signals move in one direction. There is no feedback from input to output and a layer's output does not influence the layer itself.

3.2   MULTI-LAYER PERCEPTRON NEURAL NETWORK (MLP)

MLP network is a set of neurons located in several layers after each other. After being multiplied into weights, input values reach other neurons and pass through the network function and form outputs. Ultimately outputs are compared to real values and errors are used to modify the model weights. This is called training. Figure.2 shows a simple perceptron network.
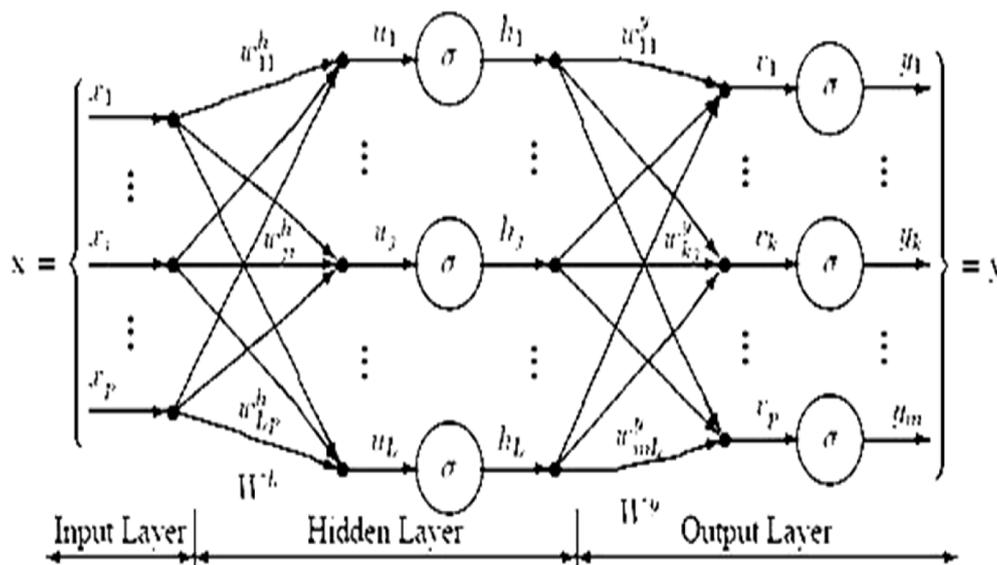

Fig. 2.   An overview of MLP

3.3 TRAINING MULTI-LAYER PERCEPTRON NEURAL NETWORK

Following equation defines perceptron output:

$$O(x_1, x_2, ..., x_n) = \begin{cases} 1 \rightarrow if \rightarrow w_0 + w_1 x_1 + ... + w_n x_n \succ 0 \\ 0 \rightarrow if \rightarrow o.w \end{cases} \tag{1}$$

Training perceptron includes finding proper values for W. Thus,in learning perceptron hypothesis space Hconsists of all real possible values for weight vectors.

Stages ofthe perceptron training algorithm are as follows:

1. Random weights are assumed

2. For every sample perceptron is applied and in case of high error rate weights are adjusted.

Are all the samples correctly analyzed?

Yes→ algorithm ends.

No→ go to the second stage

4 NUMERICAL DATA

The corresponding historical data of four effective factors are collected from 22.5.2013 to 22.5.2014 that are world gold price, world oil price, exchange rate, Iran gold coin prices.Statistical features are computed and each historical behavior of each factor is separately shown in the below charts.For further study, regression analysis has been used between each factor and the dependent variable.
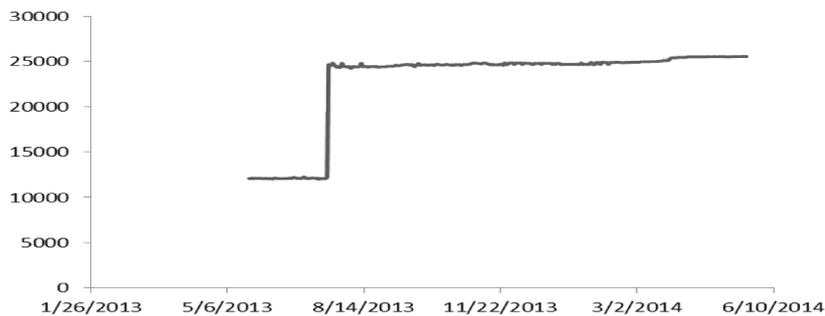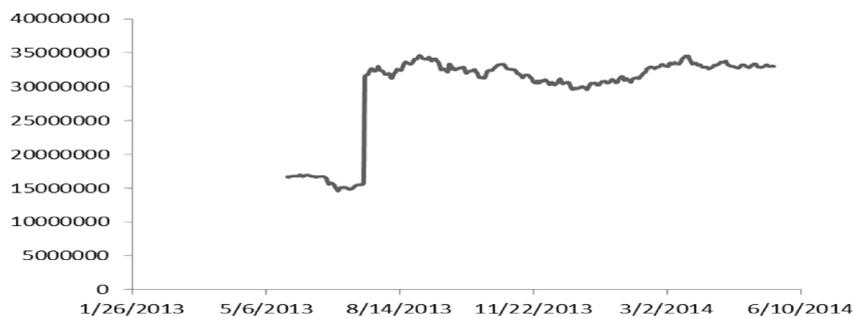

Fig. 3.   Exchange rate

Fig. 4.   Iran gold price

Fig. 5.   World gold price

Fig. 6.   World oil price

4.1   DATA ANALYSIS OF EFFECTIVE FACTORS

In the tablebelow, mean, median, max, min, standard deviation, skewness and kurtosis values are computed for each explanatory variable and descriptive statisticalvalue for each variable is presented.

Table 1.   Data analysis

	Exchange rate	World gold price	Iran gold price	World oil price
Mean	22811.46	1303.36	29704198.19	105.28
Median	24653.00	1302.90	32319925.00	105.27
Max	25541.00	1420.60	34633348.00	112.80
Min	11991.50	1195.00	14576790.00	98.33
Standard Deviation	4675.11	52.52	6053416.12	2.61
Skewness	-1.85	0.13	-1.75	-0.08
Kurtosis	1.48	-0.67	1.32	0.64

5   RESULTS

5.1   EFFECTIVE FACTORS AND GOLD COIN PRICE RELATIONSHIP

To study the effective factors on gold coin price R-squared values are computed and presented in table 2. These factors can affect each otherbut it is not considered in this paper.

Table 2. R squared values for each factor

	Exchange rate	World gold price	Iran gold price	world oil price
R squared	0.912686	0.989325	0.918024	0.982202

5.2 NEURAL NETWORK MODEL AND PREDICTING GOLD COIN PRICE

After defining the parameters, the model was coded in Matlab. Normally, designed networks consist of two or three layers. Increasing number of neurons in each layer or number of thehidden layers leadsto a model with more fitness, but its prediction capability reduces. To find an optimal number of neurons and layers, different networks are designed and ultimately a Neural Networkwas chosenwith the least Mean Square Error (MSE)which had three hidden layers and 5 neurons in each. An overview of theused Neural Network is presented in figure 7.
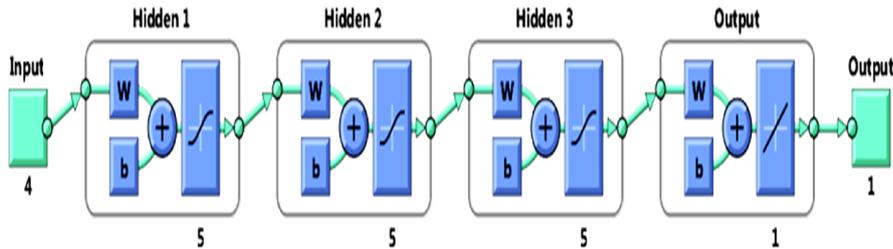

Fig. 7. Utilized Neural Network with 3 hidden layers

Also Levenberg–Marquardt training algorithm (LMA) withthefollowing parameters in table3 was used in this study.

Table 3. Utilized training parameters in the Neural Network

Maximum Epochs	epochs: 1000
Maximum Training Time	time: Inf
Performance Goal	goal: 0
Minimum Gradient	min_grad: 1e-07
Maximum Validation Checks	max_fail: 6
Mu	mu: 0.001
Mu Decrease Ratio	mu_dec: 0.1
Mu Increase Ratio	mu_inc: 10
Maximum mu	mu_max: 10000000000

70 percent of the data were used for training the model and 15 percent were used for model validation. Rest of the datawere used for testing the model. After running the model for several times it led to results with high fitness as presented in figure8.
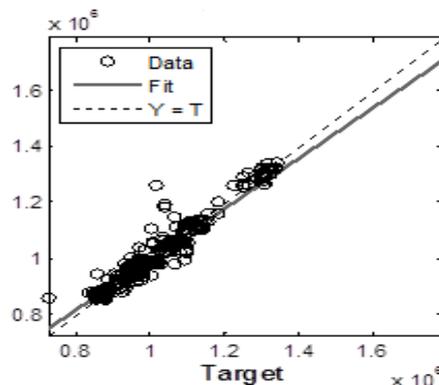

Fig. 8. Acquired fitness using Neural Network

5.3   ANALYZING THE MODEL WITH REAL VALUES

After designing and executing the model, results are compared with real values. As the illustrated below, using Neural Network proposes a proper estimation model for forecasting Bahar Azadi gold coin price and the model is suitable for gold coin price prediction. Figure.9 shows the real and estimated values for gold coin prices.Obviously Real values and estimation values have no considerable distance in Riyal between 2013/05/22 and 2014/05/22. Thus, with acceptable error value, model is favorable for estimating the gold coin price.

Fig. 9.   Real and estimated values for gold coin prices

6   CONCLUSION

In this paper four effective factors on gold coin price are analyzed: world gold price, world oil price, exchange rate and Iran gold price. Regression analysis confirmed the considerable relationship between the factors and gold coin price. A multilayer perceptron Neural Network with three hidden layers are designed for gold coin price prediction. After performing the model, estimated values are compared with real values and as the results show the model is properly capable of predicting gold coin price.

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