Application of Regression and Neural Networks for Prediction of the Profit Rise on Assets Log in Tehran Stock Exchange

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ABSTRACT

This study has investigated the effect of entering new companies to stock market. Two models are proposed to predict increased profits of assets. For this purpose, a regression model and a neural network model will be presented. To implement regression and neural network models, data are collected from 30 companies. Financial data of 3 years before privatization are used as input for the developed models to calculate their input data. In order to investigate validity of the models, the output data from each of the models have been compared with the financial information after privatization of the companies. The results of this comparison confirm validity of these models. (Finally, it is concluded that the results of neural network with real data provides a much better relationship than the regression model).

KEYWORDS: Tehran stock exchange; Financial ratios; Regression model; Neural network; Privatization.

1. INTRODUCTION

Privatization is one of the important issues in developing countries, which are now widely considered to be raised. In fact, during the past two decades, privatization has become an important global economic phenomenon. Since large-scale privatization was first launched by Tatcher's government in Great Britain, approximately $1.25 trillion has been raised through privatization. Moreover, share issue privatizations (SIPs) accounted for $750 billion between 1980 and 2000 [1]. This phenomenon is well documented for several developed and developing countries around the world. Such research had been done in the area of privatization and the following examples can be mentioned:

Boubakeri et al. [2] selected 79 companies from 23 developing countries and evaluated their operational and financial performance in three years before and three years after privatizationduring1980 to 1992. The purpose of their study was to determine whether the privatization policy in developing countries is desirable and leads to improved performance, especially profitability or not?

They have used some indicators to determine the change in profitability and operating performance. Their results have indicated that the privatization has also increased profitability of their companies. Another study was carried out by Magginson et al. [3] on privatization. In their research work, financial performance and corporate performance has been studied three years before and after privatization. They studied operational and financial performance of 61 companies in 18 countries (6 developing countries and 12 industrial countries).A financial instrument used in their study to analyze the performance and the results, was Wilcoxon Signed Ranks Test. Their findings indicated a substantial increase in profitability, efficiency, and investment, while financial leverage has been reduced.

Ramamurti [4] has studied 118 companies from 29 countries (developing and developed) in terms of financial performance and efficiency. In his study, indicators and indices of profitability and capital efficiency have been investigated three years before and three years after privatization. The results of his research revealed significant improvement in all indicators for all of the countries. Kocenda et al. [5] have studied the effect of ownership on firm performance in an extensive program of privatization within Czech Republic. They examined different types of ownership and ownership concentration during the period after transfer. In their study, variables such as operating income, revenue, labor costs and debt-to-equity ratio were investigated. Their results demonstrated that the private ownership is advantageous over the public ownership.

Bortolotti et al. [6] have studied operational and financial performance of 31 companies in 25 countries during a course of seven years from 1981 to 1998. In their study, evaluation criteria and indicators of profitability, operational efficiency and investment has been studied three years before and after privatization. Their findings were similar to the previous studies, since all indicators of improvement in private companies were listed. Omran [7] has studied privatization and examined the effect of ownership structure on performance of privatized firms to determine what type of property in the period after transfer has a positive effect on performance. He has also analyzed the financial information for two years before transferring the companies.

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Variables in his study included profit (earnings before interest and taxes, ROS, ROA, and ROE), operating efficiency, capital cost, efficiency, employment, leverage ratio, dividends and risk. The results of his study revealed a significant improvement in profitability, operating efficiency, and dividend, beside significant reductions in employment level of the employees, liability and risk.

Cook et al. [8] studied the role of privatization on economic growth of the company. In their study, 63 developing countries were reviewed during 1988 to 1997. They believe that there is a positive and large correlation between privatization and economic growth in these countries. They also argued that, however privatization will be realized for a long period, it requires further reform of laws and regulations, and rules of competition. Once a desired economy results, privatization can be followed to implement structural reforms in these countries. Narayana [9] investigated the effect of privatization on fiscal indicators, prices, quality of care, equity and ability of service providers. He has highlighted the positive effect of privatization on financial indicators, price and availability of service provision. Guohua et al. [10] investigated the effect privatization on profitability of the privatized firms in China. They addressed the profitability of private companies, while the profitability of state-owned enterprises was also considered. For this purpose, they have assessed profitability of 149 private companies versus sales performance as a measure of profitability within years 1999 to 2003.Their results suggested an improved profitability of the privatized firms in comparison with the state-owned enterprises.

Naceur et al. [11] began to survey the 95 companies that have been privatized. The considered companies are located in four countries in Middle East and North Africa. The results show that both profitability and operational efficiency have been increased considerably. Rousseau et al. [12] investigated the effects of privatization in Chinese firms which had been privatized during1994 to 2003. In this study, three financial profitability ratios (ROS, ROA and ROE) have been used. The ratios were calculated for some 116 companies three years before and three years after privatization. Marinakis et al. [13] have ranked companies using their financial ratios. For this purpose, they calculated 17 financial ratios for 1411 participants and then the financial ratios were ranked using tabu search algorithm. In this ranking, the profitability has got the first place. Rafiei et al. [14] have designed a model to predict financial health of the companies. In their study, financial ratios of 180 industrial companies listed in Tehran Stock Exchange have been used to develop the predictive models. They have used neural network and genetic algorithm approach to design the model.

Due to the benefits of privatization, many companies hold the move toward privatization, so nowadays, financial health prediction of companies after privatization is critically important. In this paper, a regression model and a neural network model will be presented to predict the increase in corporate profits.

The rest of the paper is organized as follows: regression model and regression tests are introduced in section 2. Neural network method is explained in section 3. In section 4, the results of regression model and neural network are provided. In this section, we have also presented a sensitivity analysis for the parameters and have ranked them by the neural network method. Finally, some conclusions are made in section 5.

2.   REGRESSION MODEL

In this study, regression analysis was used to examine the relationship between financial ratios. The method of ordinary least squares (OLS) is used to estimate the regression model. Three ratios of profitability (ROS, ROE, and ROA) have been applied.

The total debt ratio is used as a measure of recall due to debt capital and structure of the companies. Financial management, ratio of inventory turnover and average turnover of fixed assets were used. Finally, in the case of liquidity, the current ratio is selected as the relative ratio is more important than the immediate cash. The Regression model is presented in this paper as follows:

$$\Delta ROA = \beta_1 + \beta_2 x_1 + \beta_3 x_2 + \beta_4 x_3 + \beta_5 x_4 + \beta_6 x_5 + \beta_7 x_6 + u_t \qquad (1)$$

Where $\beta_i, i = 1,2,...,7$ are parameters of the coefficients, u_t is total error, x_1 is average ratio of the company before entering the bourse, and x_2 is average debt ratio of the company before entering the bourse. x_3 denotes average asset turnover before entering the bourse, while x_4 denotes average fixed assets turnover before entering the bourse. x_5 and x_6 represent average profit of equity before entering the stock and average profit to sales before entering the bourse, respectively. Finally, ΔROA is increased profits to finance the companies by entering the bourse.

Following issues should be noticed to estimate the model: The data must be normalized to eliminate the effect of data units. It should be considered that increasing the corporate profits also depends on some factors such as macroeconomic conditions and firm size, but in this study the impact of financial ratios only considered.

In the presented model, change rate of profit to assets is the dependent variable, while all other financial ratios are considered as the independent variables. For calculation, only the values before entering the bourse are

required. After implementation, results of the model are compared with the real data after entering listed companies.

a. Regression test

Hypothesis (i): Zero mean values of error
This hypothesis implies that the average value of error is zero ($E(u_t) = 0$). This hypothesis is ever perfect as long as there is only one constant in the regression equation.

Hypothesis (ii): Homogeneous variance
This hypothesis assumes that the error variance is constant ($\text{var}(u_t) = \sigma^2$). In this paper, white general test of variance was used to detect anisotropy. This is useful for detection of variance anisotropy due to the few test assumptions [15].

Hypothesis (iii): Lack of autocorrelation
This hypothesis states that the error covariance between components is zero over time. To test this hypothesis, the present study uses Durbin-Watson test (C. Brooks, Introductory Econometrics for Finance).

Hypothesis (iv): Deficit of multi co-linearity between independent variables
It is one of the multiple assumptions of OLS method that independent variables are not correlated with each other. Due to the difficulties of multi co-linearity test, search method is utilized in the correlation matrix between individuals.

Hypothesis (v): Admission of incorrect functional form
One of the implicit assumptions of classical linear regression model is that the functional form of these models is linear. For this purpose, Ramsey's RESET test is used in this study. By this method, fitted values of higher-order items are used in a specific regression. If the test statistic exceeds the critical value, the null hypothesis will be rejected.

Hypothesis (vi): Parameter stability test
Here is the regression of the following form:

$$y_t = \beta_1 + \beta_2 x_1 + \beta_3 x_2 + u_t \qquad (2)$$

The implicit assumption of this analysis is that β_1, β_2 and β_1 are fixed parameters for the entire sample.

This hypothesis can be validated using the parameter stability test. In this study, CUSUM test is used for parameter stability test. This statistic is based on the cumulative sum of a normalized version of waste. Under the null hypothesis based on the stability parameter, statistic is found zero. Usually a set of (+ or -) 2 times greater than the standard error is plotted around zero. If the circumstantial evidence is out of this range, the null hypothesis will be rejected.

3. NEURAL NETWORK

In this study, a neural network approach is also proposed for prediction and its results of were compared using regression method.

ANN is a data processing system which imitates brain. Neural network with the ability to derive significant results can be used to model complex data mining. Neural network consists of three layers of neurons [16-20]:

Input layer: Raw information that is fed into the network.

Hidden layers: Function of this layer is determined by the relationship between inputs as well as the weights between input and hidden layers. The weights decide when a hidden layer is active.

Output layer: Function of the output layer depends on the activity of hidden units and the weights between hidden and output layer.

4. RESULTS

To implement regression and neural network models, data are collected from 30 companies. Industrial classifications are extracted from the official website of Tehran Stock Exchange. To calculate input data for the proposed models, the financial information from 3 years before privatization were used. For investigation of the validity of the models, outputs from each of the models have been compared with the financial information after privatization of the companies.

a. Regression model

In this paper, Regression model was implemented by usingEviews.6software. Due to the limited number of data (30 items), the idea is to use the method developed by Witten et al. [21] to provide a more efficient model in the present study.

In this method, the first 10 different random samples of size 25 are selected. Then for each random sample, a regression equation is derived. As a result, 10 regression equations will be produced the final outputs of which are the average results of the 10 equations. This method makes it possible to achieve a unique prediction. The R^2 value has been reported as 0.6 for the combined model. One regression equation with the highest R^2, is shown in Table 1.

In Table 1, c is a constant value; j_1 is current ratio; B_1 represents debt ratio. M1 is inventory turnover ratio and D_1 is asset turnover ratio. ROE_1 denotes profit to asset ratio, while ROS_1 denotes profit to sales ratio. These values are all about before entering the bourse. As can be seen, these parameters explain only 64% of the model.

Table 1. Software model output.

Dependent Variable: DROA			
Method: Least Squares			
Variable	Coefficient	Std. Error	Prob.
C	1.30E-16	0.016842	1.0000
J1	0.173264	0.002325	0.7621
B1	0.289890	0.002953	0.5843
M1	-0.106204	0.002082	0.8930
D1	-0.146632	0.003548	0.4467
ROE1	-0.377688	0.044809	0.0843
ROS1	-0.153296	0.099597	0.5412
R-squared	0.641032	Akaike info criterion	-2.188544
Adjusted R-squared	0.621682	Schwarz criterion	-1.861598
F-statistic	9.479550	Hannan-Quinn criter.	-2.083951
Prob(F-statistic)	0.000027	Durbin-Watson stat	2.228598

i.   White general test

In this test, as shown in table 2, all circumstantial evidences (χ^2, *F* and *SS*) about inexistence of the anisotropy variance provide similar results. As can be seen, the p-value considerably higher than 0.05.

Table2. Results of white test.

Heteroskedasticity Test: White			
F-statistic	0.327000	Prob.	0.9362
Obs* R-squared	24.46000	Prob.	0.6043
Scaled explained SS	24.31000	Prob.	0.6129
Test Equation			
Dependent Variable:RESID^2			
Method: Least Squares			

ii.   Durbin-Watson test

The test result obtained as shown in Table 1 is equal to 2.22, which indicates that there is no autocorrelation among wastes since it is much close to 2.

iii.   Multi co-linearity

As seen in Table 3, the greatest sample correlation coefficient is equal to 0.29 which is almost negligible.

Table 3. Correlation matrix.

Correlation						
	J1	B1	M1	D1	ROE1	ROS1
J1	1.000000	0.007262	-0.107911	0.203807	0.159998	-0.038400
B1	0.007262	1.000000	-0.088973	-0.079529	-0.170136	0.191234
M1	-0.107911	-0.088973	1.000000	0.274849	0.207126	-0.286005
D1	0.203807	-0.079529	0.274849	1.000000	-0.291234	-0.092175
ROE1	0.159998	-0.170136	0.207126	-0.291234	1.000000	0.015853
ROS1	-0.038400	0.191234	-0.286005	-0.092175	0.015853	1.000000

iv. Ramsey rest test

It is evident from Table 4,the both test statistics are greater than 0.05 which confirms an appropriate linear model.

Table 4 . Ramsey rest test.

Ramsey RESET Test:			
F-statistic	2.450000	Prob.	0.1318
Log likelihood ratio	3.160000	Prob.	0.0751
Test Equation			
Dependent Variable:ROA			
Method: Least Squares			

v.   Parameter stability test
It can be observed in Fig.1 , statistic is not out of the range at 95% confidence level and this indicates stability of the parameters.
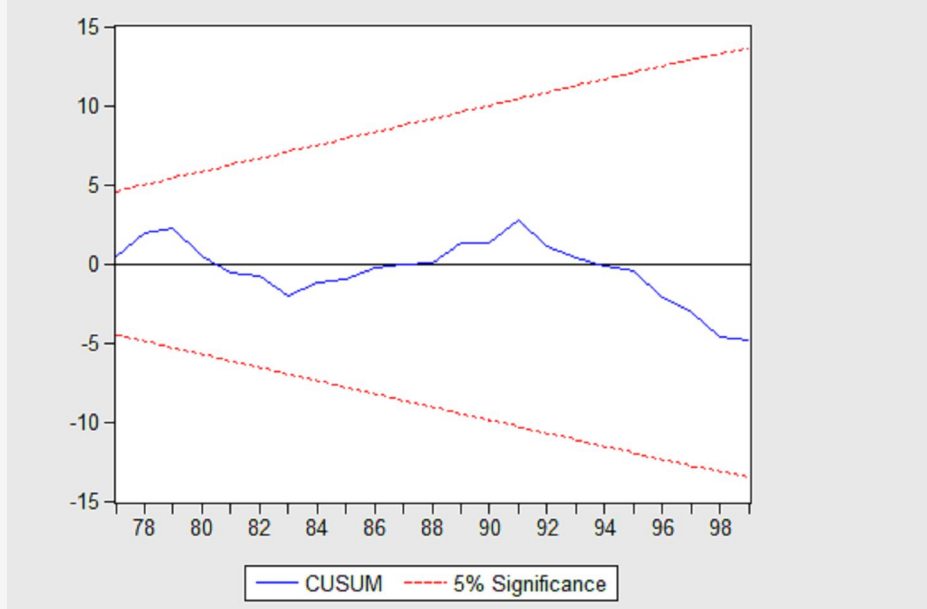

Fig 1. Results of parameter stability test

vi.   Comparison between the results predicted by this model and those of real data
vii.
Finally, comparison of the results predicted by the model with those of real data is discussed.
As is evident from Fig.2, increasing the rate of profit to assets which has been already predicted by the model is in a relatively good agreement with the real data.
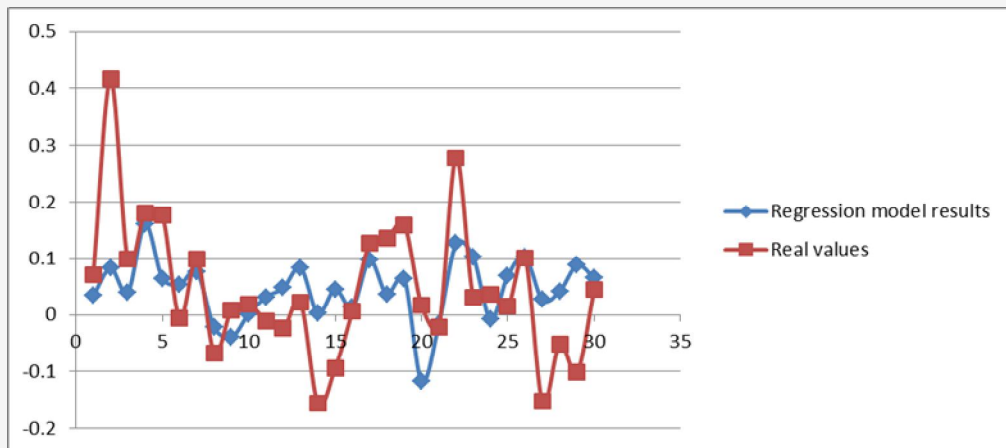

Fig 2. Regression model results compared with the real values.

b.   Neural network
In this paper, neural network method has been implemented by MATLAB software and the results are shown in Fig.3.
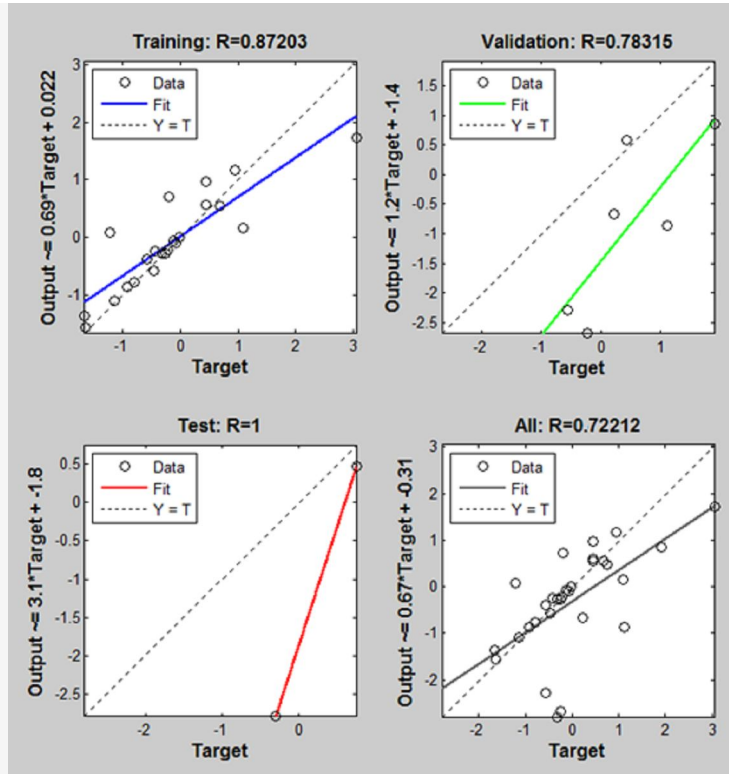
Fig 3. Results of Neural network.

It can be observed that the suggested method is able to explain 72% of model. This model is selected as a more efficient model.

i.   Comparison of the results predicted by the model with those of real data

In this section, comparison of the results predicted by the neural network model with those of real data is discussed.

Fig.4 demonstrates that increasing the rate of profit to assets predicted by the neural network model, has a relatively good agreement with the real data. The results of this model are better in agreement with the real data than the previous model.
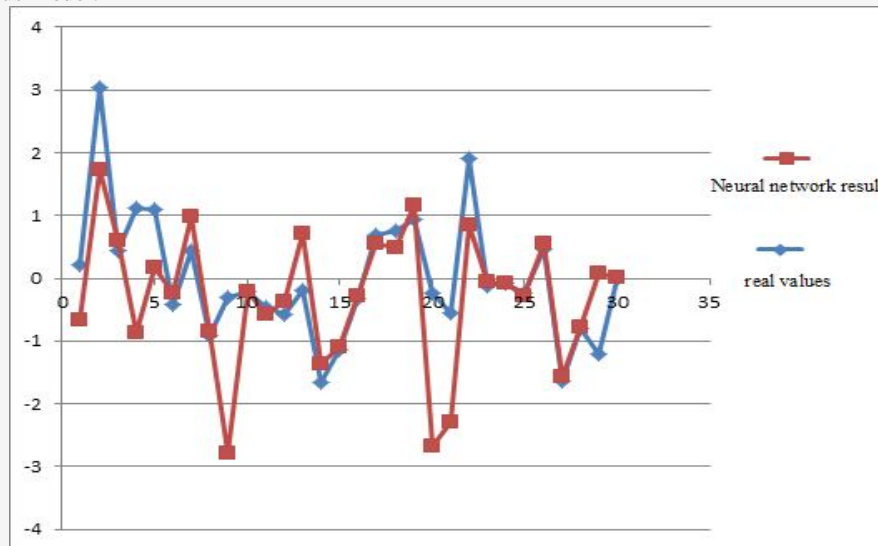

Fig 4. Neural network results compared with the real values.

ii.	Sensitivity analysis

Sensitivity analysis was performed for each parameter in the neural network and the obtained results are summarized in Table 5.

Table 5. Results of sensitivity analyze.

Range of neural network output	Rating ratios according to the greatest effect on increasing the profitability ratios
0.381	Net profit to equity(ROE1)
0.24	Debt ratio(B1)
0.22	Current ratio (J1)
0.17	Inventory turnover ratio(M1)
0.15	Asset turnover ratio(D1)
0.08	Profit to sale ratio (ROS1)

It can be observed that the rate of profit to equity has the greatest influence on increasing the profits.

## 5.	CONCLUSION

In this study, Privatization is investigated in Iran. Two models (regression model and neural network) have been suggested to predict increased profits of assets. To implement regression and neural network models, data are collected from some 30 companies. Industrial classifications are based on the official website of Tehran Stock Exchange. To calculate the input data for the proposed models, financial information are used from 3 years before privatization. The output of each model has been compared with the financial information after privatization of the companies in order to assess validity of the models. The results of this comparison show validity of these models. The regression model explains 64% of the model, while the neural network describes 72% of it. It is concluded that the results of neural network with real data have a much better agreement than the regression model. At the end, sensitivity analysis was performed for each parameter in the neural network and it can be inferred from the results that the rate of profit to equity is the most influential on increasing the profits.

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