ARTIFICIAL INTELLIGENCE AND ECONOMETRIC MODEL TO PREDICT STOCK PRICES IN THE PETROLEUM PRODUCTS INDUSTRY-TEHRAN STOCK EXCHANGE

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Abstract. Financial and economic issues, especially capital markets is one area that is important in today's forecast. Various techniques exist to predict future stock prices. Fundamental analysis is one method that considers several variables. In this paper, neural network model (RBF) and econometric panel data are used to increase efficiency, reduce costs and time in fundamental analysis. For this purpose, a sample of 35 year - company of listed companies in Tehran Stock Exchange are selected in the petroleum products industry. The results indicate good accuracy in modeling to predict the stock price on the Stock Exchange and subset of industries. Also, comparing the accuracy of econometric panel data pattern with neural networks in forecasting stock price represents the neural network has higher precision.

Key words: fundamental analysis, prices stock prediction, RBF, panel data, petroleum products industry

1 Introduction

Short-term planning in various fields for survival and persistence of activity of economic entities and effective investment and financing decisions is necessary for managers, investors, users and creditors. We can have a good reaction by planning before encountering the adverse economic events. It is necessary to improve the ability to predict accurately and consistently to increase the effectiveness of programs. Because the prediction is a key element in decisions of users within the organization and outside the organization. Therefore, efficient and effective decision would be made on the basis of correct predictions (Haghighat, Bakhtiari, Beheshtipoor, 2011). In general it can be said that the predictions is estimating future forecasts and the goal of predicting is reducing risk in decision-making. Predictions are not usually correct and have some errors, and this amount is reduced by having more information about the system. The predictive value means to the use of this information in the process of predicting. In finance the information such as stock prices, profits, returns on equity, bankruptcy and risk can be predicted. Among these, forecasting of stock price is important, because they are the factors that effect on activists decision on NYSE stock prices. The existence of related information forms basic transactions in the capital market and therefore information is the most valuable assets in capital market (Economic World Press, 2007). The main goal in these markets is to predict the future trend of prices to adopt appropriate strategies for buying or selling. However, the stock market is not affected only by the macro parameters, but another important factor effect on it (Torabi and Homan, 2010). Various techniques exist to predict future stock prices. One method that considers several variables, is fundamental analysis (Yaldiz and Yazgol, 2010).
In fundamental analysis it is believed that changes in stock market are unpredictable and the behavior of stock prices is formed in accordance with the theory of random walk (Exact date not repeatable). Several factors affect the stock price. Some of these factors are economic variables and some of the variables include: financial ratios, industry conditions, and more. Analyze economic, industry and company should to be combined to predict future stock prices using fundamental analysis. In fundamental analysis the forecasts are based on the facts and real events. Trader analyze real-world events and news based on knowledge and strategies to deal with market forecasts (Murphy, 2008). The basis of fundamental analysts is that all changes in prices has probably a financial- fundamental reason and believe that the actual intrinsic value of securities can be obtained. investors can use the potential to invest in petroleum products industry to improve efficiency, and by predicting stock prices, the companies in this industry, decided to invest more appropriate to take stock. Achieving economic growth and improving investment incentives requires an active and reliable capital markets in developing countries. This is possible through the absorption and distribution of capital and financial resources in the sector of industry (Namazi and Kyamehr, 2007).
In the past decade the financial forecasts in accounting and finance has been the subject of much research .For instance, forecasted earnings per share, stock price, earnings management, financial ruin, etc. (Peter, Vladimir and Renata, 2013). Much research have been taken in this area using statistical approaches and artificial intelligence approaches. Among the methods used, the traditional statistical methods highly dependent on assumptions such as linearity, normality, independence of predictor variables and etc (Russell and Noroyg, 2012). Previous research shows that the neural networks have predictability more than the statistical model (Olson and Masman, 2003, Arabmazar Yazdi, Ahmadi and Abduli, 2006, Kordloyi and Haideri Zare, 2010, Fahimi fard, Salarpoor and Sabouhi, 2011, Makiyan and Mousavi, 2012, 7 Chung et al, 2012). Also, if two or more models are then combined, the likelihood of achieving the best prediction increases (Nazarian et al, 2013). In addition to neural networks, econometric models are used to estimate and prediction. Time series data, cross-sectional data, panel data are these methods. Among these panel data is one of econometrics methods that that each day the desire to do it in the scientific studies expanded (Ashrafzadeh and Mehregan, 2008). Given that stock prices are one of the variables influencing investment decisions, managers and creditors, it is expected this group use advanced techniques such as artificial neural network and use panel data to predict stock prices. In this study, the panel data and artificial neural network RBF (econometric model) are used to increase effectiveness, reduce costs and fundamental analysis.

2 Theoretical Issues

With the development of financial markets and an increasing amount of information, participants in financial markets are looking for tools which can make precise predictions of the future state of market with them. With a review of previous research on forecasting in capital markets, predict models can be classified into four groups:

1. Technical Analysis
2. Fundamental Analysis
3. Econometrics
4. Intelligent Techniques

In this research the combination of fundamental analysis, intelligent forecasting and econometric (panel data) will be examined.
Fundamental analysis is based on the assumption that stock prices does not reflect all information with respect to time and is in search of information that do not reflected in the current stock price and, therefore, predict a future price adjustment. Because market prices in the future move to the basic values (Abarbanel and Boucher, 1997, 1998).

2.1 Panel data

The panel data consist of the time series data and cross-sectional data. It means the information regarding cross sectional data can be observed over time. Such data have two dimensions, which one dimension is related to a variety of units at any given time and another is related to the time. In time series data the values of one or more variables are observed over a period of time (for example GDP over the past few years). In cross sectional data the value of one or more variable are collected at the same time for a single data or a sample (for example the stock price for the 50 companies listed in a given year). But in panel data, the same cross sectional units (for example, a specific industry) are measured at the time (Gajarati, 2010).

2.2 RBF Neural Network

Research and interest in artificial neural networks began when the brain as a dynamic system with a parallel processing architecture is completely inconsistent with the known conventional processors. In 19th century, William James proposed stacks change attitudes about the physiological and brain structure. Among them may be noted in brain neurons and mechanisms for parallel processing. Function Networks are Radial Basis from the family of forward neural networks. These networks introduced for the first time by Bromhid & Low in 1998. RBF network with a variety of applications is one of the most popular neural networks and is main competitors for multilayered Persporon network. This method is different from other method due to forms of training, the function of neurons and hidden layers (Haykyn, 1998).

3 Research background

In the literature, fundamental analysis and econometric model for panel data are not presented.

3.1 Internal research

Botshekan (2000) used an artificial intelligence technique called neural networks - Fuzzy (ANFIS) for predicting stock price in Bahman company and assessed the ability this model in comparison to linear models (ARIMA).also box - Jenkins method is used to determine ARIMA model. Input variables are the price index, latest stock prices, trading volume and the price of oil. The results show superiority of Network - Neuro-Fuzzy (ANFIS) in predicting the stock price relative to the linear model (ARIMA).
According to Nazarian et al (2013) research and regards to the development of financial markets and the importance of these markets and the close relationship with macroeconomic variables the use of advanced mathematical models with complex structures to predicting the market is quite acceptable. In addition, the neural network model in comparison to other advanced models due to its high accuracy have special place, so predict volatility of stock index in Tehran stock Exchange using the daily data of stock price index between 03.25.2009 to 22.10.2011 and the reducing model with the potential long-term memory, forward neural network model and also the combination of two model. The results reflect base on the evaluation criteria of prediction error, although, the feed forward neural network model has a smaller error than the reducing model with the potential long-term memory. But the accuracy of combined model is higher than either of these two models alone.

3.2 External research

Schumann and Lohrbach (1993) predict the next day stock price in Frankfurt market by Arima and artificial neural network models. They have used the 13 given daily data for 9 years. The data is the type of technical data, also they have used an artificial neural network with two hidden layers. As a result we can't prefer these two methods together.
Feransesko & Rakesh (2012) provided a model for the predicting volatility in stock market belonging to the five founding members of the Association of Southeast Asian Nations as ASEAN-5, using the model of asymmetric APARCH with the two different distribution T-Student and GED, the aim was identify the symmetry or asymmetry in the relationship between stock returns and market volatility in ASEAN-5 market. The used data in the model were from indigenous companies of the stock market on January 2, 2002 to January 30, 2012 and are included financial turnover and the value of traded stock. The results represent superiority APARCH model and the t distribution using the prediction measurement error.
Peter, Vladimir and Renata (2013) predict the stock price with considering the quantitative data and hidden feelings (lack of assurance in reports and related terms) in the annual report and using nervous network and regression method. The used data include profitability ratios and technical analysis variables is collected from companies listed in the United States in 2010. The results showed that nervous networks provide better results especially when we consider hidden feelings in annual reports.

4 Research methodology

4.1 Research goal

In this study, the econometric model for panel data and neural network RBF are used to increase efficiency, reduce costs and fundamental analysis. So the main aim of the study is examining the accuracy of econometric model and neural network (RBF) to predict the stock price and the main question is:
Do forecast accuracy of stock prices using fundamental analysis and neural network (RBF) in the Petroleum products industry is higher than the econometric model?

4.2 Research hypothesis

The forecast accuracy of stock prices using fundamental analysis and neural network (RBF) in the Petroleum products industry is higher than the econometric model?

4.3 Population

The population is listed companies in the Tehran Stock Exchange for the Petroleum products industry during the years 2006 to 2012 that data for this study are available.

4.4 Sampling method

The sampling method are in this form that the companies that have not the following conditions are removed:
1 – The firms are accepted in the Tehran Stock Exchange before 2006.

2 - In the period of the study, the fiscal year have not changed.

3 - The sample companies have the basic financial statements for the years 2006 to 2012.

4.5 Collecting data methods and tools

The required information and data for this study has been collected using the information in the database from the Tehran Stock Exchange (Tadbirpardaz & Rahavardeh novin). The necessary information to analyze the economic situation collected from the Central Bank database. TOPSIS method is used to check the status of the industry.

4.6 Data analysis method

In this study, the econometric model for the panel data and RBF neural network are used to predict the stock price. Thus, in this section to the variables and used data, the analysis of implementation algorithm methods and evaluation criteria of models.

5 Research variables

As previously noted, in the fundamental analysis, first investors analysis and the market and economy as a whole to realize the best time for investing. Then they analysis some of the industries or economy whose future prospects are good. Finally, if the analyst conclude that the investment is appropriate and appropriate industries with high efficiency work in the economy cycle, they focus on firm analysis. The impact of the economic indicators on the industry has been studied through inflation based on the consumer index, exchange rate in open market, oil earning, volume of money and coin rate. Industries are ranked each year using TOPSIS methods and variables used for analysis of company include: Current ratio, quick ratio, current debt to equity ratio, debt to equity, debt to assets ratio, interest coverage ratio, quick asset turnover ratio, current assets turnover ratio, tangible fixed asset turnover ratio, gross profit margin, operating

profit margin, net profit margin, return on equity, return on assets, the ratio of price to earnings, ratio of book value to market value ratio, price to book value ratio, price to sales, book value of equity , return on equity, total current assets, total liabilities, earnings per share. Factor analysis was used to determine the most influential variables. In the factor analysis, the variables that have a correlation above 0.5 were in the one group and based on the eigenvalues calculated for each group combining variables were obtained (Jelif, 2002).
After determining the variables that have a correlation above 0.5 in a group, eigenvalues must be calculated to obtain combining variable. The matrix of eigenvalues which is obtained using EVIEWS7 software. The matrix of eigenvalues is multiplied by in the matrix variables that have high correlation and combining variables (PC s) is obtained.

5.1 TOPSIS algorithm used in industry rankings

Step One - normalizing decision matrix:

$$n_{ij} = \frac{r_{ij}}{\sqrt{\sum_{i=1}^{m} r_{ij}^2}} \quad (1)$$

The second step - the weighting to normalized matrix:

$$W = \{w_1, w_2, \ldots, w_n\}$$
$$V = N_D.W_{n*n} = \begin{vmatrix} v_{11} & v_{12} & v_{1j} & v_{1n} \\ v_{21} & v_{22} & v_{2j} & v_{2n} \\ v_{m1} & v_{m2} & v_{mj} & v_{mn} \end{vmatrix} \quad (2)$$

Step Three - Determine the ideal solution and negative ideal solution: Two virtual item A * and – A are defined as follows:

$$A^* = \{(\max_i v_{ij} \mid j \in J), (\min_i v_{ij} \mid j \in J') \mid i = 1, 2, \ldots, m\} = \{v_1^*, v_2^*, \ldots, v_j^*, \ldots, v_n^*\}$$
$$A- = \{(\min_i vij \mid j \in J), (\max_i v_{ij} \mid j \in J') \mid i = 1, 2, \ldots, m\} = \{v_1^-, v_2^-, \ldots, v_j^-, \ldots, v_n^-\} \quad (3)$$
$$J = \{j = 1, 2, \ldots, n \mid j \in \text{benefit}\}$$
$$J' = \{j = 1, 2, \ldots, n \mid j \in \text{Cost}\}$$

Two virtually created options are the worst and the best solution.
Fourth step - obtaining measurements of distances:

$$d_{i+} = \{\sum_{i=1}^{n} (v_{ij} - v_i^+)^2\}^{0.5}; i = 1, 2, \ldots, m \quad (4)$$
$$d_{i-} = \{\sum_{i=1}^{n} (v_{ij} - v_i^-)^2\}^{0.5}; i = 1, 2, \ldots, m$$

Step Five - calculating the relative closeness to the ideal solution: This criteria is obtained by the formula:

$$cl_{i+} = \frac{d_{i-}}{(d_{i+} + d_{i-})}; 0 \le cl_{i+} \le 1; i = 1, 2, \ldots, m \quad (5)$$

Step Six - Rating Options: finally, options are ranked according to the descending order.
In order to classify industries using TOPSIS, the variables such as return on equity, return on assets, EPS, P . E, stock return, current ratio, debt-equity ratio, operating profit margin and net profit margin are used. After using this method, Petroleum products, among the 10 industries classified on the Stock Exchange during the years 2006 to 2012 were ranked as follows in Table 1.

Table 1: Ranking the industry using TOPSIS method

Year	2006	2007	2008	2009	2010	2011	2012
ranking	7	9	10	3	2	2	10

5.2 Algorithm using panel data:

Panel data model can be demonstrated as follows:

$$y_{it} = \alpha_{i0} + \alpha_1 x_{1it} + \alpha_2 x_{2it} + \cdots + \alpha_k x_{kit} + \varepsilon_{it} \quad (6)$$

$$\varepsilon_{it} = \mu_i + \lambda_t + \nu_{it} \quad (7)$$

$$cl_{i+} = \frac{d_{i-}}{(d_{i+} + d_{i-})}; 0 \le cl_{i+} \le 1; i = 1, 2, \ldots, m \quad (8)$$

And here M_i and λ_t are imperceptible effects of individual and time respectively and v_it is residual for error component and in the matrix will be as follows:

$$y = \alpha_{NT} + X\beta + \varepsilon \quad i = 1, \ldots, N \; ; \; t = 1, \ldots, T \quad (9)$$

$$\varepsilon = Z_\mu \mu + Z_\lambda \lambda + \nu \quad (10)$$

To implement for econometric model of panel data EVIEWS7 software is used.

5.3 Neural Network Algorithm

The used RBF neural network consist of an input layer (3 neurons), the middle layer (1 to 20 neurons) and output layer (1 neuron).
In Figure 1 the method used to complete the process is shown.

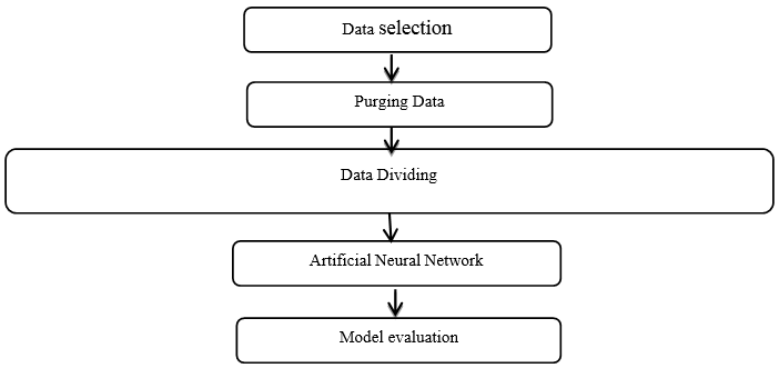

Figure 1: The process of Neural Network

After factor analysis and making appropriate and meaningful patterns the combining variable PC6 (Gross profit margin, Operating profit margin, EPS) were significant as accounting variables in fundamental analysis using panel data econometric model are not Significant economic variables of hypothesis model.

Table 2: Descriptive statistics

Model	**PC6**	**PS**
number	35	35
Mean	1.7607	4896.2857
Median	1.6061	3927
Mode	0.46	1312
S.D	1.01728	3336.8675
variance	1.035	1113468.99

Table 2 shows the descriptive statistics of the variables in the model hypothesis, including: PS (stock price), and PC6 (Gross profit margin, Operating profit margin, EPS). Stock price is dependent variable and other variables are as independent variables. In this table, number represents the observations for each variable, the mean represents the mean of observations for each variable, median reflects the moderate of observations, mode represents the highest frequency of observations for each variable, the standard deviation represent the deviation of the observation from the mean and variance is squared deviations from the mean of observations. To test for normality, standard error of skewness coefficient and Standard Error of Kurtosis are used. If the values of the indices are smaller than 2 - or greater than 2 +, the normality is rejected (Momeni & Faal Ghaiyoomi, 2012, 33). The results in Table 3 indicate that the variables are normally distributed.

Table 3: Standard error test

Model	PC6	PS
Number	35	35
standard error of skewness coefficient	0.398	0.398
Standard Error of Kurtosis	0.778	0.778

5.4 Linearity

A situation that indicates an independent variables is a linear function of other independent variables. To detect linearity two factors of variance inflation factor and tolerance were used. The minimum amount that can be a get variance inflation is one and this is in the situation that there is no linearity between the independent variables, whatever the value of this factor is greater than one, indicate better linearity between the independent variables. Also, linearity is serious when the amount of variance inflation factor is greater than 10. Regarding the variance inflation factor values in Table 4, the linearity between the independent variables is very few and the tolerance level is greater than 0.4, which is good (Momeni & Faal Ghaiyoomi, 2012).

Table 4: The linearity between independent variables

Model		tolerance	Variance inflation factor
Independent variable	PC6	0.954	1.048

Table 5 represents the mean residual is zero, which is underpinned by assumptions of regression.

Table 5: Statistical indexes in relation to the anticipated residual values

	Number of observation	S.D	mean	Max	min
Predicted Value	35	5814.5500	5603.6286	26762.8613	873.7574
Residual	35	2616.1055	0.00000	4748.56934	-8309.8623
The Predicted standardized value	35	1.000	0.000	3.639	-1.114
Standardized residual	35	0.955	0.000	1.733	-3.033

After considering the assumptions on the regression and preparing variables to build a model for selecting between integrated model and fixed effects model, the Chow test and for selecting fixed effects or random in panel data model Hausman test is used. This test has an asymptotic chi-square distribution and degrees of freedom is equal to the number of explanatory variables (regression). According to the probability column in Table 6, the results of Chow test indicates panel data model is used. Hausman test is provided for selecting between random and fixed effects.

Table 6: Test F Chow

Hypothesis	Distribution	statistic	Degree of freedom	the probability
	F	16.1505	(4.30)	0.0024
	Chi-square	13.4579	4	0.0002

Table 7: Hausman test

Hypothesis	Statistic	Degree of freedom	the probability	the result
	0.000	3	1.000	Random effects

According to the column of Table 7, the probability is more than 0.5, so random effects model is accepted. According to results, the stock price modeling by considering panel data model with fixed effects is summarized in Table 8.

Table 8: stock price modeling

Variable	The estimated coefficient	statistic t	probability
C	2535.794	4.2810	0.0002
PC6	222.3338	11.3963	0.0000
R^2= 0.730455	$\overline{R}^2$ = 0.722287	F =0.000	

As you see in above table, Note that the column probability is less than 5% for all variables, so all variables are significant and the model is suitable. The coefficient of determination represents the number of 0.7304, which represents the power produced to justify the model, it means the dependent variable is explained by the independent variables by 73%; 73% change in the stock price depends on selected variables in the model. Also the calculated probability of F-statistic is less than 5%, so the model is valid. so the selected model for predicting is valid.
Price Stock=2535.794+222.3338*PC6+ε

Table 9: Comparison of the models accuracy

		The type of error		
		RMSE	MAE	MAPE
model	Neural Network RBF	1096.954	555.987	13.739
	econometric model of Panel data	1748.319	1327.093	52.436

After construction the appropriate model to predict stock prices, according to the prediction error criteria the research hypothesis were examined. As can be observed in Table 9, the criteria of RBF neural network is less than the econometric model. Therefore, the research hypothesis (higher RBF neural network accuracy in comparison to econometric model in forecast stock price in the Petroleum products industry) is confirmed.

6 Conclusion

Prices stock prediction in the exchanges can be considered one of the most important issues that facing by stakeholders. In this paper the stock price of Petroleum products industry were predicted using fundamental analysis and econometric model for panel data and artificial neural network RBF. Considering that fundamental analysis requires large volumes of information and time to learn all the basic elements, and often is costly and time consuming for split investors, thus, the econometric model for panel data and artificial neural network RBF were used to increase effectiveness, reduce costs in fundamental analysis methods. In the literature related to fundamental analysis the use of econometric models for panel data have been neglected to predict stock prices. The variables in selected models include, Pc6 (gross profit margin, operating profit margin, EPS) were significant and determination of coefficient in model represents the power of a good justification of the model; also, the results of prediction in both models indicate a higher accuracy of (RBF) neural network into econometric model which is consistent with previous studies in the field of neural networks. Finally according to results, the selected model is proposed to help investment decisions.

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