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Providing a Model to Predict Future Cash Flow Using Neural Networks on the Pharmaceutical and Chemical Industries of Tehran Stock Market

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Abstract

Prediction of cash flows is of great importance for the inter- and extra-organizational users. The most significant objective of financial reporting is the provision of information for the prediction of such cash flows. Some experts and theorists who work on the theoretical foundations of financial reporting and its objectives believe that cash flows can be predicted from the accounting earning and its components. This research proposes a model for forecasting cash flows in firms listed on the Pharmaceutical and Chemical industries of Tehran Stock Exchange using Multi-Layer Perceptron(MLP) and Radius Based Function(RBF) neural networks and compares estimation accuracy of two models using performance criteria. In order to test hypotheses, it was used the data of 29 companies between 2006 and 2015. Findings of research indicated that the Multi-Layer Perceptron network is significantly more accurate than the Radius Based Function network and the three hypotheses were accepted.

Keywords: cash flow, feed forward, hidden layers, multi-layer perceptron, radius based function

1. Introduction

Cash flow is a vital source for any economic unit. The balance between available cash flows and cash needs indicates the economic health of firms and guarantees the continuity of their activities. Cash flows have central role in many financial decisions such as stock valuation models, and capital project evaluation methods. From an inter-organizational point of view, the ability to properly predict the outcomes of future activities, especially future cash flows, enables the efficient management of affairs and leads to optimum decisions in operational fields, investment and funds. Cash flows prediction is also important for extra-organizational users especially the investors and creditors. Operational cash flow is further used in the new financial analyses. Thus the investment policies and resource allocation will be optimized once the operational cash flow is appropriately predicted. (Saghafi and Hashemi 2004)

Within the framework of financial accounting which determines the objectives of financial reporting, special attention is paid to cash flows and the possibility of its prediction, as denoted in the announcement of Financial Accounting Concepts #1 regulated by the Financial Accounting Standards Board (FASB): "Financial reporting should provide information to help present and potential investors and creditors and other users in assessing the amounts, timing and uncertainty of prospective cash receipts from dividends or interest and the proceeds from the sale, redemption or maturity of securities and loans. The prospects for those cash receipts are affected by an enterprise's ability to generate enough cash to meet its obligations when due and its other cash operating needs, to reinvest in operations, and to pay cash dividends and may also be affected by perceptions of investors and creditors generally about the ability, which affect market prices of the enterprise's securities. Thus financial reporting should provide information to help investors, creditors, and others assess the amounts, timing, and uncertainty of prospective net cash inflows to the related enterprise." (Saghafi and Hashemi 2004)

International Accounting Standards Committee has mentioned in the International Accounting Standards #7: "Information about the cash flows of an entity is useful in providing users of financial statements with a basis to assess the ability of the entity to generate cash and cash equivalents and the needs of the entity to utilize those cash flows. The economic decisions that are taken by users require an evaluation of the ability of an entity to generate cash equivalents and the timing and certainty of their generation." (IASC, 1993)

The Iranian Committee for Accounting Standards has declared in the section of Theoretic Concepts of Financial Reporting: "Financial decisions by users of financial statements entail the evaluation of the business unit's ability in cash provision and its certainty. The estimation of cash provision ability can be facilitated through the focus on financial status and function, and unit's cash flows and their utilization in the anticipated cash flows and also by measuring its financial flexibility .(Technical Committee of Auditing Organization, 2013, p. 49)

Based on the theoretical background and financial reporting theories, one of the objectives of financial reporting is to help investors and creditors to predict future cash flows. Financial statements are the main product of financial reporting and the main tool of transferring accounting information to individuals out of the organization. To what extent the financial

statements have achieved this target, is a question taken into consideration by scholars and researchers. Furthermore, there is a disagreement on "which information is useful to predict cash flows". Revising pervious literatures indicates some scholars believe that it is possible to predict cash flows using the accounting earnings and its components. Although, classical methods such as regression models have gained successes in this context, the results have failed to satisfy the researchers. Pervious researches indicate that capital markets have a non-linear behavior, so linear and static models are unable to determine behavior of such systems. As a result, in financial sciences, non-linear models have become popular. Investors have the right to be concerned about the future of their capital, thus they seek to gain information from the future. Prediction of operating cash flows helps the investors and creditors to make proper decision to reduce investment risk as much as possible. (Pakdel et.al, 2013) With regard to what mentioned above, conducting such research is of great importance from two aspects. On one hand, it will assist managers to predict cash flow. On the other hand, it will help investors and creditors to make rational decisions.

2. Literature Review

According to pervious researches, all of them used linear models to predict future cash flows. they will be mentioned in the following sections:

2.1 International Researches

Bowen, et al (1986), Based on the previous research, they used four models with variables of net profit, net profit with depreciation, working capital obtained from the operation and previous cash flows in order to predict operational cash flows of one to two following years. The results of their research did not comply with the view of the Financial Accounting Standards Board which gives more credit to profit in predicting cash flows. (Bowen et al, 1986)

Greenberg et.al (1986), designed two models for the prediction of operational cash flows. The dependent variable in both models was the future operational cash flows while the independent variable was earning in one of the models and historical cash flows in the other one. They used correlation coefficients to rank the models, instead of directly testing their prediction capabilities. The results showed that contrary to the results of Bowen et al, net profit acts better than cash flows in predicting future cash flows. (Greenberg et al, 1986)

Finger (1994) investigated whether earning alone is a better predictor for future operational cash flows or when it is used along with cash flows. He used the time series regression model. Results showed that net profit does not predict future cash flow better than (present) cash flows. (Finger, 1994)

Lork and Willinger (1996) used seasonal data instead of annual data in order to present a better model for the prediction of future cash flows. They obtained a multiple-variable time series model using operational earning, operational cash flows and current assets and liabilities. The results of their research showed that the models based on multiple-variable time series predict the future cash flows in a better way. According to the findings of their research, accrual components have a better capability for predicting future cash flows

compared to (present) cash flows which complied with the claims of FASB. (Lork and Willinger, 1996

Barth, et.al (2001), proposed a modified version of Dechow, Kothari and Watts model. They disaggregate the accruals into components, anticipating them to have different persistent in predicting future cash flows. (Barth, et.al, 2001)

Lork and Willinger (2008), Found that cash flow prediction error using accounting earning and accruals in large companies is significantly smaller compared with small companies. (Lork and Willinger, 2008)

Lork and Willinger(2009) tested time-series and cross-section cash flow prediction models. They found that time series models are much better than cross-section models in predicting future cash flows. In addition, there is no significant difference between the ability of accounting earnings and cash flow in predicting future cash flow as independent variables. (Lork and Willinger, 2009)

2.2 Local Researches

Kordestani (1996) who followed Finger method in his research, examined the ability of accounting earning to predict earning and future cash flow. The results indicated that no model enables to predict the future cash flow in a way to be close to real data, but accounting earning is a top predictor than cash flow. (Kordestani, 1996)

Jannat Rostami (1999) examined the role and ability of accounting earning in predicting earning and investing future cash flow on the listed firms in Tehran stock exchange. Results from his research indicated that there is a significant relationship between pervious earning with future earning as well as pervious earnings and cash flow with future cash flow. (Janat Rostami, 1999)

Modares and Dianati Deilami (2003) examined the use of multivariate time series models in predicting operating cash flows using data of 40 companies during 1967-1998. Findings indicated that the model based on cash flows, accounting earnings and accruals related to current debts and assets is the most suitable model to predict operating cash flows. (Modares and Dianati Deilami, 2003)

Saghafi and Hashemi (2004) examined the relationship between operating cash flows and accruals based on Barth's model. The sample consisted of 71 listed firms in Tehran stock exchange during 1995-2004. Independent variables include operating cash flows, receivables, prepayments, inventories, accounts payable, prepaid income, depreciation cost, and variations of Provision for Staff termination benefits. Findings indicated that simultaneous use of operating cash flows and disaggregated accruals result more precise prediction of operating cash flows. (Saghafi and Hashemi, 2004)

Gholamalipour (2004) after dividing accruals into discretionary and non-discretionary parts, examined the ability of non-discretionary accruals in predicting cash flows and future earnings using a sample of 55 companies during 1999-2003. Results indicated that simultaneous use of non-discretionary accruals and operating cash flows rather than the

model which uses only non-discretionary accruals can predict future cash flows more precise. (Gholamalipour, 2004)

Saghafi and Fadaei (2007) in their research found that models based on accruals than models which use cash flows have more prediction ability. (Saghafi and Fadaei, 2007)

MirFakhraldini et al. (2009) tested three various models such as(earning, cash flow, cash flow and disaggregated accruals of accounting earning)and found that these models can predict future operating cash flows. They also found that additional time periods of accounting data can improve prediction ability of models. (Mir Fakhraldini et al, 2009)

Saghafi and Sarraf (2013), in a research compared two models such as (random walk and Accrual reversal) to predict operating cash flows and examined some features of company which affect prediction models. For this, a sample consisted of 1663 year-company in Tehran stock exchange was selected. Findings indicated that the random walk model compared with the accrual reversal model can predict operating cash flows in a better way. (Saghafi and Saraf, 2013)

Sarraf et.al (2013) examined the effect of cash flow and accruals in predicting future cash flows using linear and non-linear regression models. In this regard, 287 companies were selected during 2003-2011 and correlation coefficient methods were used to analyze data. In addition, prediction ability of models was compared using sum square error criterion. Findings indicated that the accrual regression model can predict operating cash flows better than other models. Among company's characteristics, there is the highest correlation between instability of sale and company size using accrual regression models. (Saraf et al, 2013)

3. Artificial Neural Network Theory

An artificial neural network consists of a series of interconnected neurons. Each series is called a layer. The Role of neurons in neural networks is information processing. Information is processed via a mathematical processor called an activation function. An activation function is selected based on the problem which is supposed to be solved. The simplest form of a network has two layers.

Input and output layers work out as an input-output system. They use the value of input neurons to calculate the value of output. Neural networks with Hidden Layer have more abilities than two-layer networks. (Pakdel et.al, 2013)

3.1 Multi-layer Perceptron Neural Network

Feed Forward multilayer networks refer to the most used architecture of neural networks, called Multilayer Perceptron networks. These networks have the features as follows:

1-Network processors are divided into several layers

2-Minimum number of layers in these networks is two

3-Processeors of each layer receives signal from the processors of previous layers, and their output is applied to the next processors.

In MLP networks, first layer is called input, last layer is called output and middle layer is called hidden. Inputs are effective parameters in determining outputs. Thus, the numbers of nodes for input and output layers are known since starting the use of network. Number of hidden layer's nodes as well as number of hidden layers is obtained via try and error. Indeed, suitable number of nodes and hidden layers is obtained when the network gives the best response. (Pakdel et al., 2013).In this research, tangent sigmoid transfer function was used to train MLP network. Sigmoid activation function is as follow:

$$Sgm(x)=1/1+exp(-1) \quad (1)$$

The main cause of success of using the above function would be of its learning algorithm. The algorithm used in this neural network (MLP) is feed forward. This algorithm seeks to minimize sum square errors. This is similar to regression coefficients estimation via OLS in econometrics and statistics. Thus, each neural network follows an error function like equation below:

$$\varepsilon_t=1/2e^2 \quad (2)$$

In this equation, "e" indicates the observed error value. In designing a network, parameters of network structure such as, type of learning algorithm, learning rate, number of network layers and number of neurons for each layer and number of Epochs for each pattern during learning should be adjusted. (Pakdel et. al, 2013).

3.2 Radius Based Function Neural Network (rbf)

Radius Based Function Neural Networks are feed forward with three layers: input layer, hidden layer and output layer. RBF networks require more neurons, while other networks are designed at a fraction of time required for training. Turning errors to zero on input data is the main advantages of using RBF networks. On the other hand, in these networks, there is no need to determine the number of neurons in hidden layer, because they equal to the number of input vectors. (Pakdel et al. 2013)

4. Research Objectives

Providing a model to predict future cash flow using MLP and RBF neural networks in firms listed on the Pharmaceutical and Chemical industries of Tehran Stock Exchange is the main purpose of this research. In addition, other secondary objectives are also considered. They include:

* Helping investors and creditors in making optimal decisions.

* Helping managers to disclose operating cash flow which is considered the way to access the first target.

5. Research Questions and Hypotheses

To achieve the above targets, the research questions are as follows:

1-Is Multi-Layer neural network a suitable model in predicting cash flows for sample firms?

2- Is RBF a suitable model in predicting cash flows for sample firms?

3- Is MLP neural network superior to RBF Network in predicting future operating cash flows for sample firms?

With regard to questions above, three hypotheses are presented:

first hypothesis: A Multi-Layer Perceptron neural network is a suitable model to predict future cash flow for sample firms.

second hypothesis: A Radius-Based Function neural network is a suitable model to predict future cash flow for sample firms.

third hypothesis: A Multi-Layer Perceptron neural network is superior to Radius-Based Function network in predicting future cash flow for sample firms.

6. Statistical Population and Sample Firms

In the present research, Statistical population consists of firms listed on the Pharmaceutical and Chemical industries of Tehran Stock Exchange during 2006-2015. The elimination method was used for the selection of sample firms. Thus all companies in statistical population that met conditions below have been considered as the sample firm. The conditions are as follows:

1-They must have been accepted into Tehran stock exchange before fiscal year 2006

2-Their fiscal year must ends in December 30th

3-Their share must have been transacted once per three month during the research period.

4-They should be manufacturing companies.

After applying the above criteria, 29 firms were selected as the sample. The number of firms in the statistical sample is shown in Table 1.

Table 1. Number of firms in the statistical sample

Code of industry	Type of industry	Companies accepted into Tehran Stock Exchange before 2006	Number of samples
1	Pharmaceutical	28	18
2	Chemical	27	11
Sum		55	29

*Research Findings

In order to train network, the samples were divided into two training and testing categories, so that seventy percent of data were allocated to training category and the rest were allocated to test category. Then the network was trained and tested using training and testing data.

7. Research Methodology

This research is an applied and a quasi-experimental study. In this research, MLP and RBF neural networks were created to predict future operating cash flows and then their performance was compared to select the optimal model. Since prediction in neural networks is made based on learning on input variables, they are considered as major factors in modeling via neural networks. In table 2, input variables were shown. In order to homogenize variables, they were divided by the average assets per period.

Table 2. Input variables

Operating cash flow of company i in the year t	$CFO_{i,t}$
Changes in accounts receivable of company i in the year t	$\Delta AR_{i,t}$
Changes in prepayment of company i in the year t	$\Delta PPE_{i,t}$
Changes in inventory of company i in the year t	$\Delta INV_{i,t}$
Changes in accounts payable of company i in the year t	$\Delta AP_{i,t}$
The cost of depreciation of tangible and intangible assets of company i in the year t	$DEP_{i,t}$
Variations of Provision for Staff termination benefits of company i in year t	$\Delta PR_{i,t}$
Other accruals of company i in the year t	$OTHERS_{i,t}$

*Research Findings

The model consists of an output variable which is future operating cash flow. At the next stage, the data were prepared. Preparation of data is one of the complicated stages in the use of neural networks. A part of this complexity depends on the selection of proper training patterns and another part depends on changes in scale of data, because the best status for neural networks is when all the inputs and outputs range from 0 to 1. (Pakdel et.al,2013). In this research, normalized data has been used as inputs via MLP and RBF neural networks to predict future cash flow and their performance was compared with each other to select the best model. All data analysis was done using MATLAB software.

8. Results

In this research, prediction of operating cash flows was done using MLP and RBF neural networks in firms listed on the Pharmaceutical and chemical industries of Tehran Stock Exchange. Thus, to evaluate the performance of models, some performance assessment criteria have been used. These criteria are related to the error between outputs and targets. In the present research, three common performance assessment criteria have been used: Mean Square Error(MSE), Root-Mean Square Error(RMSE), and R square(R2).

8.1 Prediction of Operating Cash Flow via MLP Network

To achieve the best prediction error using MLP networks, training is made via various network parameters to gain optimal error. To this end, network was trained with more than 100 patterns to achieve an acceptable error level. Structural parameters of final model which resulted optimal error are presented in Table 3.

Table 3. Parameters of final MLP network

Number of Epochs	Number of neurons in hidden layer	Learning rate	Transfer function
15000	20	0.1	Tangent sigmoid

*Research Findings

In order to examine the accuracy of the neural network, three performance criteria were used. The results of these criteria were reported in Table 4.

Table 4. Results of performance assessment using MLP network

	MSE	RMSE	R^2
Testing data	0.07212	0.26855	0.89367
Training data	0.0599	0.24474	0.91746

*Research Findings

Furthermore, total number of errors to epochs for test and training data has been represented in Figures 1 and 2.

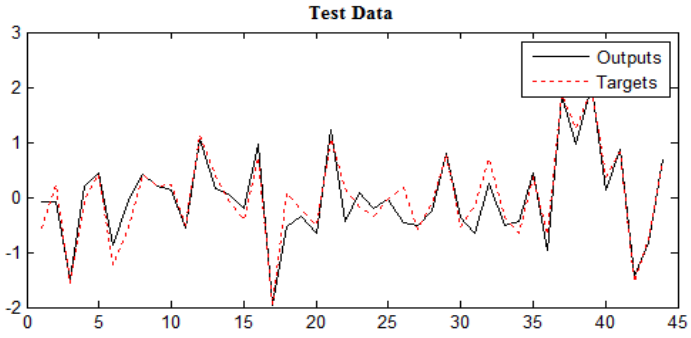

Figure 1. Total number of errors to epochs for test data

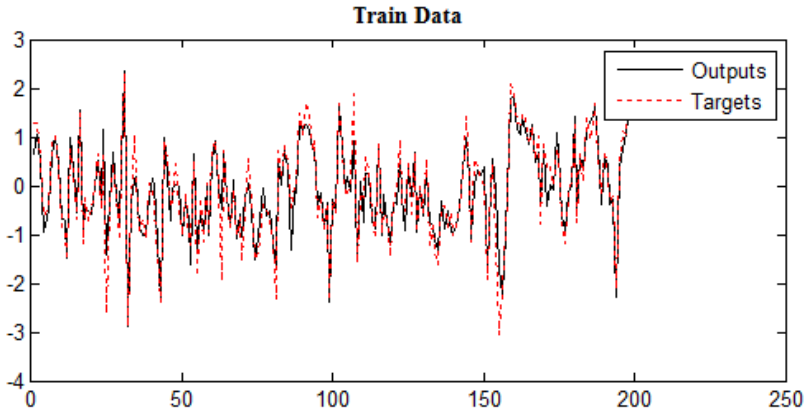

Figure 2. Total number of errors to epochs for training data

8.2 Prediction with RBF Network

The results of performance criteria using RBF network have been presented in Table 5.

Table 5. Results of performance assessment using RBF network

	MSE	RMSE	R^2
Testing Data	0.24468	0.49465	0.71555
Training Data	0.068908	0.2625	0.91423

*Research Findings

Total number of errors to epochs for test and training data has been presented in Figures 3 and 4.

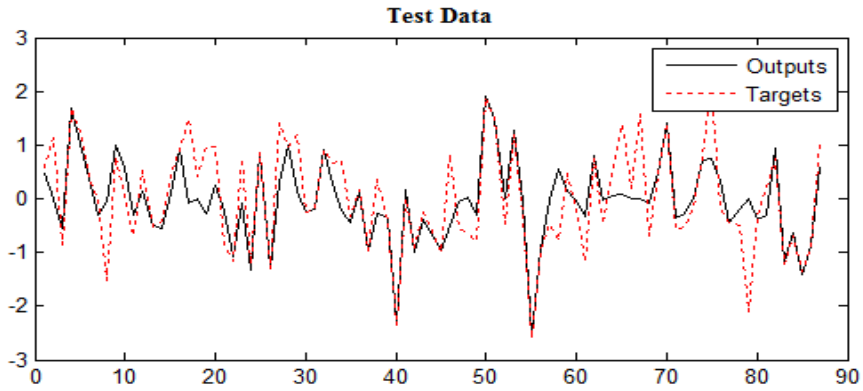

Figure 3. Total number of errors to epochs for test data

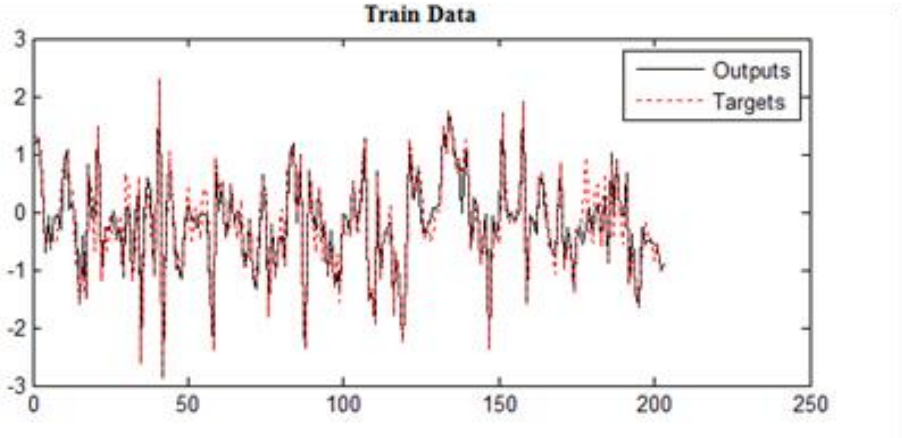

Figure 4. Total number of errors to epochs for training data

9. Discussion and Conclusion

As it was mentioned earlier, cash flow prediction in firms listed on the Pharmaceutical and Chemical industries of Tehran Stock Exchange is the main purpose of this research. According to pervious researches, eight fundamental accounting variables were considered as inputs data. In addition to the confirmation of the superiority of non-linear models to linear models in predicting future cash flows, the results indicated that MLP network has better performance. Table 6 displays the results of performance assessment in two models which are related to test data.

Table 6. Performance assessment of MLP and RBF neural network

Networks	Data Type	MSE	RMSE	R^2
MLP	Test	0.07212	0.26855	0.89367
RBF	Test	0.24468	0.49465	0.71555

*Research Findings

Using test data is the basis for decision making on the accuracy of each network. Among three assessment criteria, MSE and RMSE are related to the measurement of standard error. The less the mentioned indices is, the better the prediction is. R square coefficient indicates that how many percent of changes in dependent variable has been explained by independent variables. Value of R square coefficient ranges from 0 to 1, i.e. value 1 indicates putting all data on regression line. As a result, the closer R square coefficient to 1 is, the better the model is. Based on the first and second models, independent variables have explained 89and 71 percent of changes in dependent variable, respectively. With regard to definitions above and table 6, MLP network is superior to RBF network based on three performance assessment criteria since it has less MSE and RMSE compared with RBF network and also has higher R square coefficient value. It should be noted that the results confirm three hypotheses. The results also indicate the relationship between cash component and disaggregated accruals of accounting earning with future operating cash flow. Findings are consistent with the results of Lorek, K.S., and Willinger, G.L.(1996), Barth, M., Cram,D., and Nelson, K.(2001), Dianati(2004), Saghafi & Hashemi(2004), Saghafi and Fadaei(2007), Mir fakhreldini et al(2009).

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