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Refining Ohlson Model for Valuing Bank Stocks- An Artificial Neural Network Approach

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ABSTRACT

This study performs and compares the accuracy of Simplified Ohlson model and Refined Ohlson model using Artificial Neural Network (ANN) for valuing bank stocks. Prediction accuracy measuring procedures are used to compare the performance of these models. This study also focused on comparing the predictive power of Simplified Ohlson Model & Refined Ohlson Model (using ANN) using coefficient of determination. The outcomes of predictions are discussed to know the power of Artificial Neural Network. The results of empirical analysis support that Refined Ohlson model using ANN can be used as a valuation tool to provide better and more accurate estimation of equity stock prices of banks.

Key words: Ohlson Stock Valuation Model, Prediction Accuracy, Artificial Neural Network.

INTRODUCTION

Prediction of bank stock price is generally believed to be a very difficult task. Artificial Neural Networks (ANN) have been used in stock market prediction during the last decade. An ANN model is a computer model whose architecture essentially mimics the learning capability of the human brain.The processing elements of an ANN resemble the biological structure of neurons and the internal operation of a human brain. In some applications it has been specified that artificial neural networks have limitations for learning the data patterns or that they may perform inconsistently and become unpredictable because of the complex financial data used. In US Stock market, artificial neural networks are mostly used in predicting financial failures. There has been no specific research for prediction of stock market values in Indian stock market using Artificial neural network. The main objective

of this study is to enhance, revise and refine the Ohlson valuation model for Indian bank stocks (included in the BSE Bankex) using artificial neural network. This will help to improve the accuracy for valuing bank stocks in Indian Stock Market.

REVIEW OF LITERATURE

Karl Nygren (2004) study found that error correction neural network could be successfully used as decision support in a real trading situation and proved that it is successful in stock market. According to Mahdi Pakdaman Naeini (2010), application of Multi Layer Perceptron (MLP) neural network model is more promising in predicting stock value changes rather than Elman recurrent network and linear regression methods. Dase R.K (2010) presented a review of literature on application of Artificial Neural Network for stock market predictions and from this literature it is found that Artificial Neural Network is very useful for predicting world stock markets.

Ramon Lawrence (1997) discovered patterns in nonlinear and chaotic systems and found that neural networks offer the ability to predict market directions more accurately than current techniques. Akinwale Adio (2009) stated that neural Network used error back propagation algorithm and regression analysis to analyze and predict untranslated and translated Nigeria Stock Market Prices. Kunwar Singh Vaisla (2007) showed a method to forecast the daily stock price using neural networks and the result of the Neural Network forecast is compared with the Statistical forecasting result. In this paper, Neural Networks and Statistical techniques are employed to model and forecast the daily stock market prices and then the results of these two models are compared. The results show that Neural Networks, when trained with sufficient data, proper inputs and with proper architecture, can predict the stock market prices very well. Adebiyi Ayodele A.,Ayo Charles K. (2009) used data mining techniques which can be used extensively in the financial markets to help investors to make qualitative decision. This study presented a hybridized approach which combines the use of the variables of technical and fundamental analysis of stock market indicators for prediction of future price of stocks and obtained showed remarkable improvement over the use of only technical analysis variables.

Tong-Seng Quah, Bobby Srinivasan (1999) found that ANN is used as a tool to uncover the intricate relationships between the performance of stocks and the related financial and technical variables. Emin Avci (2009) intended to examine the power of neural network models in the prediction of daily returns of the selected stocks from ISE-30 index. The performance of the neural network models was evaluated by trading profits. The results of the study presented that the neural network models could beat the buy-and-hold strategy for most of the period under investigation.

The study concluded that neural network models were also effective in stock return forecasting for the selected stocks. M. Thenmozhi (2006) applied neural network models to predict the daily returns of the BSE (Bombay Stock Exchange) Sensex. The multilayer perceptron network was used to build the daily returns model and the network was trained using the error Back Propagation algorithm. It is found that the predictive power of the network model is influenced by the previous days return than the first three-days inputs. The study showed that satisfactory results can be achieved when applying neural networks to predict the BSE Sensex.

Yusuf Perwej (2012) examined the feasibility of the prediction task and provided evidence that the markets are not fluctuating randomly and finally suggested to apply the most suitable prediction model. Birgul Egeli (2010) proved that Artificial neural networks have better performances than moving averages. Şenol Emir (2012) concluded that the stock performance results relying on fundamental analysis have shown more successful classification rates than the models based on technical analysis. A.D.Dongare (2012) presented the model of network that throws the light on the concept of inputs, weights, summing function, activation function & outputs of ANN. It helped in deciding the type of learning for adjustment of weights with change in parameters. Reza Aghababaeyan (2012) proved that using Neural Network Standard Feed-Forward Back Prop (FFB) algorithm resulted in better prediction accuracy results in Tehran Stock market. Vidushi Sharma (2012) stated that Need of Artificial Intelligence is increasing because of parallel processing. Parallel Processing is more needed in this present time because it save more and more time.

Sneha Soni (2011) surveyed the recent literature in the domain of machine learning techniques and artificial intelligence used to predict the stock market movements. Artificial Neural Networks (ANNs) are identified to be the dominant machine learning technique in the stock market prediction area. Third, artificial neural networks have been claimed to be general function approximations. It is proved that an MLP neural network can approximate any complex continuous function that enables us to learn any complicated relationship between the input and the output of the system. Abbas Vahedi (2012) aimed at predicting the stock price in Tehran Stock Exchange Using Artificial Neural Network for annual data from 2000 to 2008. Results showed that estimation and predictions of stock price with Artificial Neural Network is possible and have suitable and stronger results. Best architecture is a network with two hidden layers and two neurons in hidden layers with hyperbolic tangent transfer function both in hidden and output layers with Quasi -Newton training algorithm. Victor Devadoss (2013) predicted stock price of Bombay Stock Exchange (BSE) using Multilayer Networks with dynamic back propagation.The stock prices are determined and compared with two different architectures NN1 (3-16-1) and NN2 (3-6-1). Neural Network based forecasting of

stock prices of selected sectors under the Bombay Stock Exchange show that neural networks have the power to predict prices albeit the volatility in the markets.

Priyadarsini (2013) focused on comparison of the performance of ARIMA and ANN models for the net asset values of Sahara Mutual fund- Growth for a period of 6 years (from 2006 to 2012). Mean Absolute Error (MAE), Mean Square Error (MSE), Mean Absolute Percentage Error (MAPE), Root Mean Square Error (RMSE) and Mean Percentage Error (MPE) are used to evaluate the accuracy of the models. In all these error estimates ANN model performs much better than ARIMA model. G Sundar & K Satyanarayanan (2015) stated that Stock market data are highly time-variant and are normally in a nonlinear pattern, predicting the future price of a stock is highly challenging. This study motivated to study the possibilities of applying different types of neural network in predicting the share market prices in India. Mahboobah Shefie, Hoda Majbouri, Hamid Panahi, Hamid Hesari (2013) aimed to investigate the relationship between independent variables and stock returns using data mining techniques and it has tried to answer the question of whether a model can be presented to forecast stock returns using support vector machine and decision tree techniques. Applying the existing data to the support vector machine, stock returns are forecasted with an accuracy of 92.16, which is better than the decision tree with 9 degrees of freedom with a probability of almost one hundred percent.

Prashant S Chavan (2013) surveyed different input parameters that can be used for stock market prediction with ANN. He tried to find out most important input parameters that have a major impact on accuracy. It is seen that most of machine learning techniques made use of Technical variables over fundamental variables for a particular stock price prediction, while microeconomic variables are mostly used to predict stock market index. Qasem A, Al-Radaideah, Adel Abu Assaf, Eman Alanngi (2013) tried to help the investors in the stock market to decide the better timing for buying or selling stocks based on the knowledge extracted from the historical prices of such stocks. The decision taken will be based on decision tree classifier which is one of the data mining techniques. The Proposed model can be a helpful tool for the investors to take the right decision regarding their stocks based on the analysis of the historical prices of stocks in order to extract any predictive information from that historical data. Selvan Simon and Arun Raoot (2012) surveyed different ANN models that have been experimented in SMP with the special enhancement techniques used with them to improve the accuracy. This study explored the possible research strategies in this accuracy driven ANN models. ANN models have outperformed other traditional models. Also, MLP with BP training found to be the most widely used ANN models in SMP. Various statistical techniques may be used to pre-process the data for improving performance. Also, special algorithms may be combined with ANN to improve accuracy. The above studies deal with use of ANN for accurate

prediction of stock prices. But, this study has refined the Ohlson Valuation model and then using ANN tried to improve the predictive power and valuation accuracy of Indian bank stocks.

OBJECTIVES OF THE STUDY

- To examine the predictive power & valuation accuracy of Ohlson model for Bank stocks in India.
- To refine the Ohlson Valuation model using Artificial neural network approach.
- To validate the improvement of Refined Ohlson Model in terms of predictive power and valuation accuracy.

RESEARCH METHODOLOGY

This is an empirical study. It used secondary data. The data were collected from the CMIE Prowess database, annual reports and BSE websites. The sample for this study includes the 14 constituent banks of BSE Bankex. The period of the study ranges from March 2002-03 to March 2013-14. Study selected independent variables and dependent variable of each bank to perform ohlson model & Refined ohlson valuation model from March 2002-03 to March 2013-14 from CMIE Prowess database for the analysis purposes. Multiple regression is used to know the combined impact of these accounting variables on bank stock prices constituting BSE Bankex. The independent variables used in the ohlson model include Earnings after tax, Book value of equity, Dividend paid, Risk free rate, Number of outstanding shares and dependent variable is market price. The independent variables used in the refined ohlson model include Earnings after tax, Book value of equity, Growth rate in Book value of equity, risk free rate and number of outstanding shares and dependent variable is market price. The variables used for the Ohlson valuation model are given in Table I and the variables used for refined Ohlson valuation model are given in Table II.

Table I: List of Variables for OhlsonValuation Model using ANN

1.	Market Price(Dependent Variable)
2.	Earnings (Independent Variable)
3.	Book value of Equity(Independent Variable)
4.	Dividend paid (Independent Variable)
5.	Risk free rate(Independent Variable)
6.	Number of Outstanding shares(Independent Variable)

Table II: List of Variables for refined OhlsonValuation Model using ANN

1.	Market Price(Dependent Variable)
2.	Earnings (Independent Variable)
3.	Book value of Equity(Independent Variable)
4.	Growth rate in Book value of Equity(Independent Variable)
5.	Risk free rate(Independent Variable)
6.	Number of Outstanding shares(Independent Variable)

Coefficient of determination(R^2) is used for comparing the explanatory power of both valuation models in valuing the bank stocks included in BSE Bankex. Valuation accuracy of each bank stock is measured by calculating the Mean Absolute Percentage Error (MAPE) between the target bank's estimated price and actual stock price. A low percentage error is regarded as high valuation accuracy, while high percentage error indicates low accuracy. BIAS indicates the undervalued vs overvalued errors or signed errors of bank stocks. In order to establish statistical significance, Paired T test is carried out to evaluate the comparative prediction accuracy between Ohlson model and Artificial Neural Network method (Refined Ohlson Model using ANN).

Methodology for Artificial Neural Network Approach

Refined Ohlson model expressed the intrinsic value of a Equity per share as function of Earnings, Risk Free Rate , Book Value of Equity, Growth rate in Book value of equity, and number of outstanding shares.

$$\text{Pit (Intrinsic value of Equity per share)} = \frac{\{ X_i / R_f) + (BV_i - (BV_{i-1}) \}.}{\text{No of O/S Shares}}$$

Where

X_t = Earnings

R_f = Risk free rate

BV_i = Predicted Book value,where i ε {1,2,…12}

BV_{i-1} = Last year Book value

No of O/S Shares= Number of outstanding shares

Here simple Ohlson model has been revised by calculating the predicted book value(BV_i) using the new formula. Formula for predicted book value (BV_i) is given below.

$$BV_i = \{(BV_{i-1})+ \{(BV_{i-1})* \text{Growth rate in Book value}\}$$

This research work is to improve the accuracy of stock price prediction of 14 bank stock prices included in BSE Bankex. This research is using artificial neural networks for the above refined Ohlson Model on improving valuation accuracy. The study used multi layer perceptron model and this model has been trained with a back propogation algorithm that is used in feed forward Artificial Neural Network. The learning function or the activation function that was used is sigmoid function.Variables and architecture of the refined ohlson valuation model is given as follows. Architecture of this model cosists of five input variables as Earnings, Book value of equity, Growth rate in book value of equity, Risk free rate, Number of outstanding shares in the input layer, five intermediate variables in the hidden layer and one output variable as Market price in the output layer used in Artificial neural network. Figure I illustrates the schematic diagram of 5-5-1 topology of multi layer perceptron model. The five steps represent the procedures involved in the back propogation algorithm for the Ohlson Model.

Step I - First apply inputs to the network and workout the output.

Step II - The Activation of back propogation of neural network is effected by applying Sigmoid function.

$$f(x) = \frac{1}{1+ e^x}$$

Because it was found from literature on related problem domain to be most widely used and perform better than other functions such as the Unit Step function, Piecewise linear function, Binary Transfer function, and Gaussian function.

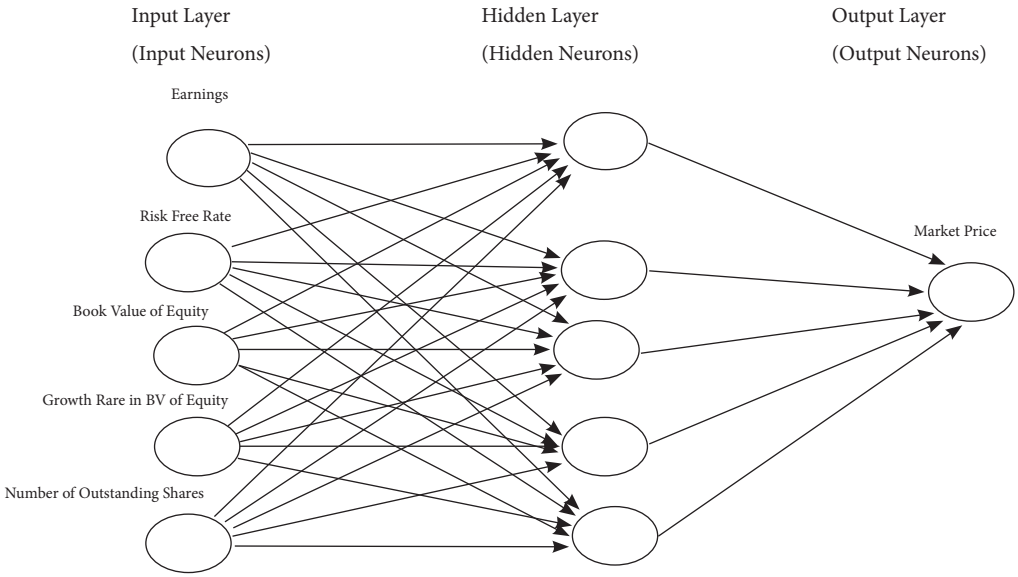


Figure I: MultiLayer Perceptron Model

Step III- Next work out the error for output neuron. Let Output Neuron be B.

$$Error_B = Output_B (1-Output_B) (Target_B-Output_B).$$

The "Output(1-output)" term is necessary in the equation because of the sigmoid function. If we were only using threshold neuron it would just be (Target-output) and weights are updated in the back propogation .Calculate the error gradient for the neurons in the output layer for adjusting wieights in that layer.

Next work out the error for hidden neuron. Unlike the output layer , error cannot be calculated directly. So it has to be back propogated from the output layer. It is done by taking errors from the output neuron and running them back through the weights to get the hidden layer errors. Let A be the Hidden layer neurons, Then

$$Error_A = Output_A (1- Output_A) (Error_B * W_{AB})$$

Then calculate the error gradient for the neurons in the hidden layer for adjusting the weights in that layer.

Step IV- Having obtained the error for the hidden layer neurons now proceed as in the step iii .

Step V- Repeat the process until the selected error criteria is satisfied.

By repeating this method, network of any number of layers can be trained . Here single input layer with 5 input neurons, Hidden layer with 5 hidden neurons, Output layer with one output neuron are used for the training purpose. The idea is to train a network by propagating the output errors backward through the layers. The errors serve to evaluate the derivatives of the error function with respect to the weights, which can then be adjusted. It involves a two-stage learning process using two passes: a forward pass and a backward pass. In the forward pass, the output (O_j) is computed from set of input patterns, X_i. This can be expressed mathematically as: $O_j = f(\Sigma w_{ij} x_i, \theta_j)$ Where f is a nonlinear transfer function, e.g. sigmoid function, θ_j is the threshold value for neuron j, xi is the input from neuron i and w_{ij} represents the weight associated with the connection from neuron i to neuron j. After computing the output of the network, the learning algorithm is then applied from the output neurons back through the network, adjusting all the necessary weights on the connections.

HYPOTHESIS

The following null hypothesis is tested:

H_{01}: Valuation accuracy of Ohlson Model does not equals the Refined Ohlson Model.

RESULTS AND ANALYSIS

In this study, multiple linear regression models have been used to determine the explanatory power of Ohlson model & Refined ohlson model. The purpose of the study is to present both valuation models to the Indian banking sector and test which model explains the largest proportion of the cross-sectional variation in equity values. For comparing the explanatory power of research models in valuing the stock of banking companies included in the BSE Bankex, this study used adjusted R-square of the models.

Table III: Regression Results for Simplified Ohlson Valuation Model

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.799[a]	.638	.627	55.183	1.291

Analysis of Variance

	Sum of Squares	Diff	Mean Square	F	Sig
Regression	2210527.73	5	4442105.548	101.68	.000[a]
Residual	6814595.606	156	43683.305		
Total	29025123.34	161			

Coefficients

	Regression Coefficient		Standardized Coefficients	T	Sig	Collinearity Statistics	
	B	S.E.	Beta			Tolerance	VIF
Constant	5.492	65.649		.084	.933		
Earnings	.176	.021	1.033	8.52	.000	.103	9.73
R_f	2992.67	1013.8	.122	2.95	.004	.880	1.13
BV equity	-.066	.070	-.055	-.948	.344	.454	2.20
Dividend	-.083	.100	-.109	-.827	.410	.087	11.4
No of O/S shares	-2.296	.600	-.196	-3.82	.000	.575	1.73

Residual Statistics

Predicted Value	12.2233	2296.9702	409.70	371.42	162
Residual	-354.249	864.2555	.0000	205.734	162
Standardised Predicted value	-1.070	5.081	.000	1.000	162
Standardised Residuals	-1.695	4.135	.000	.984	162

a. Predictors: (Constant),Earnings,R_f, BV Equity, Dividend, No of O/S Shares
b. Dependent Variable: Market price of share
Note: Results computed by using SPSS 17.1

Table III shows the model summary of the regression for the accounting variables of bank stocks included in BSE Bankex for the Ohlson model. The value of R is equal to 79.9% and R-square of the model is equal to 63.8%. This means that 63.8% of change in the dependant variable ,viz, Market price is due to the variations in the independent variables used in the Ohlson model. From the Table iii, it is clear that earnings and risk free rate are positively and significantly influencing the market price of share. Whereas, the number of outstanding shares are negatively and significantly influencing the market price of shares.

Table IV: Regression Results for Refined Ohlson Valuation Model using Artificial Neural Network

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
2	.859 [a]	.738	.730	88.011	.996

Analysis of Variance

	Sum of Squares	Diff	Mean Square	F	Sig
Regression	23103608.56	5	4620721.713	88.011	.000[a]
Residual	8190235.591	156	52501.510		
Total	31293844.15	161			

Coefficients

	Regression Coefficient		Standardized Coefficients	T	Sig	Collinearity Statistics	
	B	S.E	Beta			Tolerance	VIF
(Constant)	-16.91	71.93		-.235	.814		
Earnings	.161	.008	.915	19.39	.000	.754	1.32
BV	-.091	.065	-.077	-1.39	.164	.548	1.82
Growth in BVequity	28418.6	11889	.099	2.39	.018	.968	1.03
Risk free rate	3453.25	1103.4	.136	3.12	.002	.893	1.12
No of O/S shares	-2.315	.648	-.200	-3.57	.000	.533	1.87

Residual Statistics

Predicted Value	-8.5327	2326.17	420.21	378.81	162
Residual	-349.263	1189.29	.0000	225.54	162
Standardised Predicted value	-1.132	5.031	.000	1.000	162
Standardised Residuals	-1.524	5.190	.000	.984	162

a. Predictors: (Constant) Earnings, BV, Growth in BV equity. RF, No of o/s shares
b. Dependent Variable: Market price of share
Note: Results computed by using SPSS 17.1

The estimation output of the Refined Ohlson model using ANN shows that the model has a very high explanatory power ($R^2 = 0.738$ on average). This suggests that Book Value of Equity and the growth rate in Book value of equity are the important variables in explaining the market equity values of bank stocks. Adjusted R^2 of .730 indicates that regressed factors are able to explain 73% of the variation in the dependant variable (share price) of this model. From the Table iv, it is clear that earnings, risk free rate and growth in book value of equity are positively and significantly influencing the market price of share. Whereas, the number of outstanding shares are negatively and significantly influencing the market price of shares.

Heteroscedasticity and Multicollinearity Test: From the Table , it is clear that the residuals are identically distributed with mean zero and equal variances and hence, the model does not face a problem of heteroscedasticity

By comparing both of these valuation models one can reach to conclusion that the Refined Ohlson Model using ANN which captures the spirit of clean surplus relation is the most appropriable model for equity valuation. The refined ohlson model using ANN outperforms the Simplified Ohlson Model for the bank stocks in Indian Stock market in terms of its predictive power.

Given the estimation of models, it is important to evaluate and compare the accuracy of both models (Simplified Ohlson Model and Refined ohlson model using Artificial Neural network) for bank stocks. This paper employ Mean absolute percentage error (MAPE) to evaluate the model to know the accuracy and BIAS to know the undervalued errors and overvalued errors for bank stocks. This study estimated the intrinsic values of all bank stocks included in the BSE Bankex over the periods from 2002-03 to 2013-14 for both valuation models. Then the estimated values for each bank stock were then compared with actual prices for the last 12 years to test the accuracy and stability of the estimates for both valuation models. Table v shows the results of comparing the accuracy results of simplified Ohlson Model and Refined Ohlson Model using Artificial neural network model. The accuracy of the prediction was measured using mean absolute percentage error and the results were quite outstanding for Artificial Neural network.

Table V: Accuracy comparison between Ohlson Valuation Model Vs. Refined Ohlson Valuation Model using Artificial Neural Network

Name of Bank	Ohlson Model		Refined Ohlson Model (Using ANN)	
	Mape	Bias	Mape	Bias
HDFC Bank	45.14	26.29	50.67	33.71
ICICI Bank	41.85	-8.95	45.33	-4.22
SBI Bank	40.72	-38.89	40.58	-35.25
Axis Bank	31.9	-27.5	30.33	- 23.17
Kotak Mahindra Bank	216.90	201.32	2.35	220.19
Bank of Baroda	61.56	-61.57	59.33	-59.37
Punjab National Bank	60.89	-60.90	58.5	-58.50
Indusind Bank	63.07	4.95	65.67	9.42
Yes bank	80.75	50.72	.89	61.76
Canara Bank	61.52	-67.11	65.27	-65.08
Federal Bank	63.17	-57.29	61.83	-54.90
Bank Of India	59.83	-70.14	62.83	-62.76
Union Bank Of India	59.72	-65.15	55.17	-55.12
IDBI	57.62	-57.62	55.17	-55.12
Valuation errors	67.47	-16.56	46.71	-10.60

As it is shown in Table V, value of mean absolute percentage errors , signed mean of error percent for BSE Bankex will be decreased significantly after using training in neural network which will be show the increase of estimation factor in trained neural network. Neural networks are quicker than other methods including regression because they are executing parallel and tolerate more errors and also these networks can make rules without any implicit formula which are understandable in an environment of chaos especially in developing the stock valuation model . The model had a mean square error of 2.35 (Kotak Mahindra Bank), 0.89 (Yes Bank), 30.33(Axis Bank) and kept at very low level for all these bank stocks using Artificial neural network.

Since data used for prediction in all the models are same, here paired t-test (two samples for mean) is carried out on prediction accuracy to test the hypothesis. The results of paired t-tests are shown in Table VI. The evidence indicate that valuation accuracy of Simplified Ohlson model do not equal to Refined Ohlson Model using ANN. Hence, the Null hypothesis is accepted.This conclusion, however, also indicates that the prediction error of Simplified Ohlson model is higher than the Refined Ohlson Model using Artificial Neural Network Model.

Table VI: Paired T test between Simplified Ohlson Model Vs. Refined Ohlson Model using Artificial Neural Network

Tests	Df	t-Stat	P value	Conclusion
Ho1=Ohlson vs ANN	13	1.299	.216	mO > mANN

Where, mO, mANN are, mean prediction errors of Simplified Ohlson Model and Refined Ohlson Model using Artificial Neural Networks respectively.

Artificial Neural Network performs better than the Simplified Ohlson Model for forecasting bank stock prices. This is due to the reason that the average error in Refined Ohlson Model using Artificial Neural Network is very less than the Simplified Ohlson method. The experiments illustrate a varying degree of predictability of bank stock returns using the above two forecasting techniques. Its ability to predict the ups and downs of stock price was much more amazing , though, it did not achieve 100 percent level of accuracy for all bank stocks in BSE Bankex.

SCOPE FOR FUTURE WORK

This paper attempted to prove the fact that Artificial Neural Networks helps in forecasting stock market prices through Refined Ohlson Model. The logical next step for the research is to improve further the performance of ANNs. This can be achieved perhaps through better training methods, better architecture selection, or better inputs.

CONCLUSION

In this paper, two techniques for modeling and forecasting stock market prices have been shown: Simplified Ohlson Model and Refined Ohlson model using Artificial Neural Network. The forecasting ability of models is assessed on the basis of MAPE and BIAS. ANNs can be used naturally in predicting stock market trends. Under normal conditions, in most cases, a good neural network will outperform most other predictive models and be a very worthwhile and potentially profitable aid to investors. However, the difficulty in identifying good raw data, pre-processing this data, training a network and repeating this process until a good model is developed should not be discounted. Regardless of ANNs outputs in the Refined Ohlson Model, a user should always do their due diligence prior to investing in bank stocks as investment.

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