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Refining Price to Earnings Model For Valuing Bank Stocks – An Artificial Neural Network Approach

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Abstract

This study performs and compares the accuracy of Price to Earnings model and Refined Price to Earnings 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 Price to Earnings Model & Refined Price to Earnings 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 Price to earnings model using ANN can be used as a valuation tool to provide better and more accurate estimation of equity stock prices of banks.

Keywords: *Price to Earnings Valuation Model, Prediction Accuracy, Artificial Neural Network*

1. Introduction

An Artificial Neural Network (ANN), often just called a neural network, is a set of interconnected links that have weights associated with them. The concept of ANN was derived from biological neural networks. ANN can be thought of as a set of interconnected units broadly categorized into three layers. These three layers are the input layer, the hidden layer and the output layer. Inputs are fed into the input layer, and its weighted outputs are passed into the hidden layer. 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 of banks in Indian stock market using Artificial neural network. 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 main objective of this study is to enhance, revise and refine the Price to Earnings 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.

2. Review Of Literature

S. Neenwi (2013) Focused on developing investment portfolios using artificial neural network. The simulation results and price forecasts show that it is possible to consistently earn good returns on investment on the Nigerian stock market using private information from an artificial neural network indicator. Muhammed A rezi (2005) performed a three-way comparison of prediction accuracy involving nonlinear regression, NNs and CART models using a continuous

dependent variable and a set of dichotomous and categorical predictor variables. NNs and CART model produced better prediction accuracy than non-linear regression model in this study. Mayyankumar B patel (2014) aims at using of Artificial Neural Network techniques to predict the stock price of companies listed under LIX15 index of National Stock Exchange (NSE). It is noticed that Artificial Neural Network technique is very useful in predicting stock indices as well as stock price of particular company.

Mukesh and Rohini (2015) have been used two MLP Neural Networks, one is trained using Least Mean Square algorithm and another one using Sigmoid Delta algorithm. Results have shown that MLP Neural Network has lower RMS error than MLP Neural Network with sigmoid delta learning algorithm.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. 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.

Karl Nygren (2004) 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. 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. ?enol 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 (MAPE) 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.

3. Objectives of the Study

1) To examine the predictive power & valuation accuracy of Price to Earnings model for Bank stocks in India.
2) To refine the Price to earnings Valuation model using Artificial neural network approach.
3) To validate the improvement of Refined Price to earnings Model in terms of valuation accuracy.

4. 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 Price to earnings model & Refined Price to earnings 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 Price to earnings model include Beta, EPS Growth rate, DPR, EPS and dependent variable is market price. The independent variables used in the refined Price to earnings model include Repo rate, EPS Growth rate, DPR, EPS and dependent variable is market price. The variables used for the Price to earnings valuation model are given in Table 1 and the variables used for refined Price to earnings valuation model are given in Table 2.

Table 1: List of Variables for P/E Valuation Model

1.	Market Price(Dependent Variable)
2.	Beta (Independent Variable)
3.	EPS Growth rate(Independent Variable)
4.	DPR(Independent Variable)
5.	EPS(Independent Variable)

Table 2 : List of Variables for Refined Price to Earnings Valuation Model Using ANN

1.	Market Price(Dependent Variable)
2.	Repo rate (Independent Variable)
3.	EPS Growth rate(Independent Variable)
4.	Dividend payout ratio (Independent Variable)
5.	EPS(Independent Variable)

Coefficient of determination(R2) 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

Price to earnings model and Artificial Neural Network method (Refined Price to earnings Model using ANN).

Methodology for Artificial Neural Network Approach

Refined Price to earnings model expressed the intrinsic value of a Equity per share as function of Repo rate, EPS Growth rate, Dividend Payout ratio, and EPS.

A direct test and relationship between Repo rate, EPS Growth rate , Dividend Payout ratio, EPS and Market price has been studied by using regression analysis. Relationship between the variables has been studied by regressing the Repo rate , EPS Growth rate ,Dividend payout ratio against average Price Earnings ratio to predict the P/E ratio on yearly basis.

Predicted P/E it = $\alpha 0 + \alpha 1$ *REPO it* + $\alpha 2$*GROWTH it* + $\alpha 3$ *DPR it* + *e it*

Estimated price of target firm *i* at time t, *PE'* it

Intrinsic value = Predicted *PE i* x *EPS* it

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 Price to earnings 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 Price to earnings valuation model is given as follows. Architecture of this model cosists of four input variables as Repo rate, EPS Growth rate, Dividend payout ratio, EPS in the input layer, intermediate variables in the hidden layer and one output variable as Market price in the output layer used in Artificial neural network. Figure 1 illustrates the schematic diagram of 4-4-1 topology of multi layer perceptron model. The five steps represent the procedures involved in the back propogation algorithm for the Price to earnings Model.

Step1 - First apply inputs to the network and workout the output .

Step 2 - The Activation of back propogation of neural network is effected by applying Sigmoid function.

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

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.

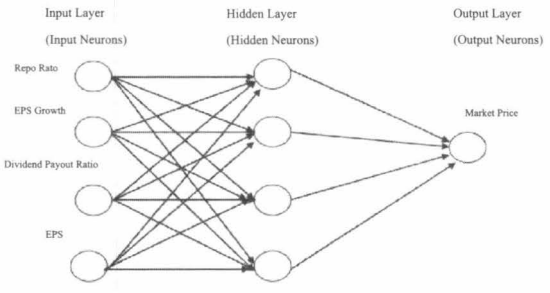

Figure-1 Multi layer perceptron model- Refined Price to Earnings model

Step 3- 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.

Step4- Having obtained the error for the hidden layer neurons now proceed as in the step 3 .

Step 5- 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 4 input neurons, Hidden layer with 4 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 (Oj) is computed from set of input patterns, Xi. This can be expressed mathematically as: Oj = f (Σ wij xi, θj) Where f is a nonlinear transfer function, e.g. sigmoid function, θj 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.

5. Hypothesis

The following null hypothesis is tested:

H_{01}: Valuation accuracy of Price to earnings Model does not equal the Refined Price to earnings Model.

6. Results and Analysis

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

Table 3: Regression Results for Price to Earnings Valuation Model

Model Summary					
Model	*R*	*R Square*	*Adjusted R Square*	*Std. Error of the Estimate*	*Durbin-Watson*
1	.808 a	.654	.645	252.82912	.899

Analysis of Variance					
	Sum of Squares	*Diff*	*Mean Square*	*F*	*Sig*
Regression	18989280.56	3	4747320.142	74.267	.000a
Residual	10035842.17	158	63922.565		
Total	29025123.345	161			

Coefficients							
	Regression Coefficient		*Standardized Coefficients*	*T*	*Sig*	*Collinearity Statistics*	
	B	*S.E.*	*Beta*			*Tolerance*	*VIF*
Constant	451.456	119.872		3.76	.000		
EPS	8.699	.513	.801	16.9	.000	.989	1.01
Beta	-206.996	64.476	-.151	-3.21	.002	.994	1.00
EPS Growth	-11.766	4.060	-.147	-2.89	.004	.861	1.16
DPR	-1.700	2.689	-.032	-.632	.528	.871	1.14

Residual Statistics					
Predicted Value	-66.1342	1834.6960	409.70	343.43	162
Residual	-594.83	889.65	.0000	249.66	162
Standardised Predicted value	-1.386	4.149	.0000	1.000	162
Standardised Residuals	-2.353	3.519	.0000	.987	162

a. Predictors: (Constant),EPS, Beta ,EPS Growth, DPR
b. Dependent Variable: Market price of share
Note: Results computed by using SPSS 17.1

Table 3 shows the model summary of the regression for the accounting variables of bank stocks included in BSE Bankex for the Price to earnings model. The value of R is equal to 80.8% and R-square of the model is equal to 65.4%. This means that 65.4% of change in the dependant variable ,viz, Market price is due to the variations in the independent variables used in the Price to earnings model. From the Table 3, it is clear that EPS is positively correlated and significantly influencing the market price of share. Whereas, the beta and eps growth are negatively and significantly influencing the market price of shares.

Table 4: Regression Results for Refined price to earnings Valuation Model using Artificial Neural Network

Model Summary					
Model	*R*	*R Square*	*Adjusted R Square*	*Std. Error of the Estimate*	*Durbin-Watson*
2	.785 a	.617	.607	63.191	.737

Analysis of Variance					
	Sum of Squares	*Diff*	*Mean Square*	*F*	*Sig*
Regression	19303632.07	4	4825908.018	63.191	.000a
Residual	11990212.08	157	76370.778		
Total	31293844.15	161			

Coefficients							
	Regression Coefficient		*Standardized Coefficients*	*T*	*Sig*	*Collinearity Statistics*	
	B	*S.E.*	*Beta*			*Tolerance*	*VIF*
(Constant)	-221.932	186.84		-1.18	.237		
EPS Growth rate	-8.871	4.457	-.106	-1.99	.048	.854	1.17
Repo rate	55.129	20.864	.135	2.642	.009	.940	1.06
EPS	.589	3.010	.011	.196	.845	.831	1.20
DPR	8.592	.564	.762	15.23	.000	.976	1.02

Residual Statistics					
Predicted Value	-19.4897	1874.0681	420.213	346.233	162
Residual	-542.7866	1138.837	.0000	272.898	162
Standardised Predicted value	-1.270	4.199	.0000	1.000	162
Standardised Residuals	-1.964	4.121	.0000	.987	162

a. Predictors: (Constant) EPS Growth rate,Repo rate, EPS,DPR
b. Dependent Variable: Market price of share
Note: Results computed by using SPSS 17.1

The estimation output of the Refined Price to earnings model using ANN shows that the model has a very high explanatory power ($R^2 = 0.617$ on average). This suggests that EPS Growth rate, Repo rate ,EPS,DPR are the important variables in explaining the market equity values of bank stocks. Adjusted R^2 of .607 indicates that regressed factors are able to explain 60.7 % of the variation in the dependant variable (share price) of this model. From the Table 4, it is clear that repo rate, EPS and DPR are positively and significantly influencing the market price of share. Whereas, EPS Growth rate is 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 Price

to earnings Model predictive power is also satisfatory. The refined price to earnings model does not outperform the Price to earnings 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 (Price to earnings Model and Refined price to earnings 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 5 shows the results of comparing the accuracy results of simplified price to earnings Model and Refined price to earnings 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 5: Accuracy Comparison Between P/E Valuation Model Vs. Refined P/E Valuation Model Using Artificial Neural Network

Name of Bank	*P/E Model*	*Refined P/E Model (Using ANN)*		
	Mape	Bias	Mape	Bias
HDFC Bank	38.81	31.37	12.74	-10.14
ICICI Bank	61.27	48.94	26.19	-13.16
SBI Bank	34.17	-28.80	26.75	-17.06
Axis Bank	30.36	-4.98	29.13	-8.86
Kotak Mahindra Bank	193.27	187.82	116.14	93.12
Bank of Baroda	60.11	-29.16	57.19	-57.19
Punjab National Bank	47.78	-47.78	52.62	-52.62
Indusind Bank	118.02	13.52	84.16	-55.41
Yes bank	61.18	-2.62	38.22	-38.13
Canara Bank	46.44	-46.44	57.74	-57.74
Federal Bank	64.65	-64.65	58.57	-58.57
Bank Of India	45.54	-37.93	55.19	-55.19
Union Bank Of India	58.56	-17.33	53.95	-53.02
IDBI	45.63	-45.63	59.09	-59.09
Valuation errors	***64.69***	***-3.12***	***51.97***	***-31.64***

As it is shown in Table 5, value of mean absolute percentage errors for BSE Bankex will be decreased significantly after using training in neural network which will be shown 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 12.74 (HDFC Bank), 26.19 (ICICI Bank), 26.75 (SBI Bank) and 29.13 (AXIS Bank) 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 6. The evidence indicate that valuation accuracy of Price to earnings model do not not equal to Refined Price to earnings Model using ANN. Hence, the Null hypothesis is accepted. This conclusion, however, also indicates that the prediction error of Price to earnings model is higher than the Refined price to earnings Model using Artificial Neural Network Model.

Table 6 : Paired T test between Price to Earnings Model Vs. Refined Price to Earnings Model using Artificial Neural Network

	Df	*t-Stat*	*P value*	*Conclusion*
Ho1=P/E Model vs ANN	13	1.941	.074	mO > mANN

Where, mO, mANN are, mean prediction errors of Price to earnings Model and Refined Price to earnings Model using Artificial Neural Networks respectively.

Artificial Neural Network performs better than the Price to earnings Model for forecasting bank stock prices. This is due to the reason that the average error in Refined Price to earnings Model using Artificial Neural Network is very less than the Price to earnings 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.

7. Scope for Future Work

This paper attempted to prove the fact that Artificial Neural Networks helps in forecasting stock market prices through Refined price to earnings 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.

8. Conclusion

In this paper, two techniques for modeling and forecasting stock market prices have been shown: Price to earnings Model and Refined Price to earnings 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. Results showed that estimation and predictions of stock price with Artificial Neural Network for Refined P/E Model is possible and have suitable and stronger results. Finally it is proved that relative valuation accuracy for bank stocks has been improved using Artificial neural network .

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