A COMPARATIVE ANALYSIS OF PREDICTION USING ARTIFICIAL NEURAL NETWORK AND AUTO REGRESSIVE INTEGRATED MOVING AVERAGE

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ABSTRACT

Box Jenkin's Auto Regressive Integrated Moving Average (ARIMA) technique is one of the most sophisticated extrapolation methods for prediction and Artificial Neural Network (ANN) is a modern non linear technique used for prediction. This paper compares the performance of both these models for the net asset values of Sahara Mutual fund-Growth for a period of 6 years (from 2006 to 2012) and the 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.

Keywords: prediction, artificial neural network (ANN), auto regressive integrated moving average (ARIMA).

1. INTRODUCTION

Since the global economy is expanding at a faster rate, mutual funds investment has been considered as the safest bet for many retail and corporate customers who are subscribing to their various schemes. Hence it is necessary to study the relationship between the net asset values of different types of mutual funds and certain macro economic variables using modern techniques. Apart from this, stock market aggregate movement also becomes an influencing factor for mutual funds. Prediction becomes much simpler if the factors that affect the net asset values of the mutual fund is known.

2. LITERATURE REVIEW

Recently several researchers like Baestaens et. al. [1], Katsurelis [6], Kamath [5] recommends the Artificial Neural Network (ANN) as the forecasting tool for investigating the co-integrating relationship as well as forecasting in capital markets. There have been several studies on examining the relationship between the economic variables and the stock market in Indian context. Weak-form efficiency of the BSE was evaluated by Sharma Kennedy [10] and Sharma [11]. In a recent study under NSE Research Initiative, Kamath [5] uses Artificial Neural Network (ANN) to examine the relationship of macro-economic factors to the returns of individual assets [8]. Bhattacharya & Mukherjee [2], Rao & Rajeswari [9] have used advanced methods in econometrics to study the same relationship.

3. ARTIFICIAL NEURAL NETWORK

Artificial Neural Network uses the optimization tools to learn from past experiences and predicts and identifies new patterns using the prior training. ANN network simulates our brain functions and is composed of parallel computing units called Neurons. Neurons can be connected in various ways to form different Neural Network architectures. The most popular architecture is the multi-layer perceptron (MLP) which consists of two or more layers of neuron connected in sequential manner. These neurons are in turn connected to other neurons in the different layer by weighted path ways [4].

Signals are sent through these pathways to the other neurons. The weighted signals are summed by each neuron and the resulting signals are transformed as the output of the neuron using an activation function. This output signal is then sent to the other neurons in the subsequent layers. The input layer receives the signals obtained from the data entering the network and the final output layer generates the result [7].

4. PREDICTION USING ANN

The five predictors for ANN are the monthly averages of several economic variables like the Whole sale price Index (WPI), Crude Oil Rate, Gold Rate, US dollar Rate and NSE Index. Data were modeled using ANN for a period of six years between 2006 and 2012 and the net asset values of Sahara Mutual Fund-Growth for the succeeding month was predicted. The various error estimates like Mean Absolute Error, Mean Square Error, Root Mean Square Error, Mean Absolute Percentage Error and Mean Percentage Error were calculated for the predicted data. The network details of the ANN are given in Table-1 and the network diagram is shown in Figure-1 and the chart of actual versus predicted is shown in Figure-2.

5. FORECASTING WITH ARIMA MODEL

Autoregressive Integrated Moving Average (ARIMA) is one of the popular linear models in time series forecasting popularized by George Box and Gwilym Jenkins since 1980s. It is also called as Box-Jenkins models [3].

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Table-1. Network details.

Input layer	Covariate	1	WPI
		2	CRUOIL
		3	GOLD
		4	USD
		5	NSE
		Number of units[a]	5
		Rescaling method for covariates	Standardized
Hidden layer		Number of hidden layers	1
		Number of units in hidden layer 1[a]	3
		Activation function	Hyperbolic tangent
Output layer	Depend variable	1	SAHARA
	Number of units		1
	Rescaling method for scale dependents		Standardized
	Activation function		Identity
	Error function		Sum of squares

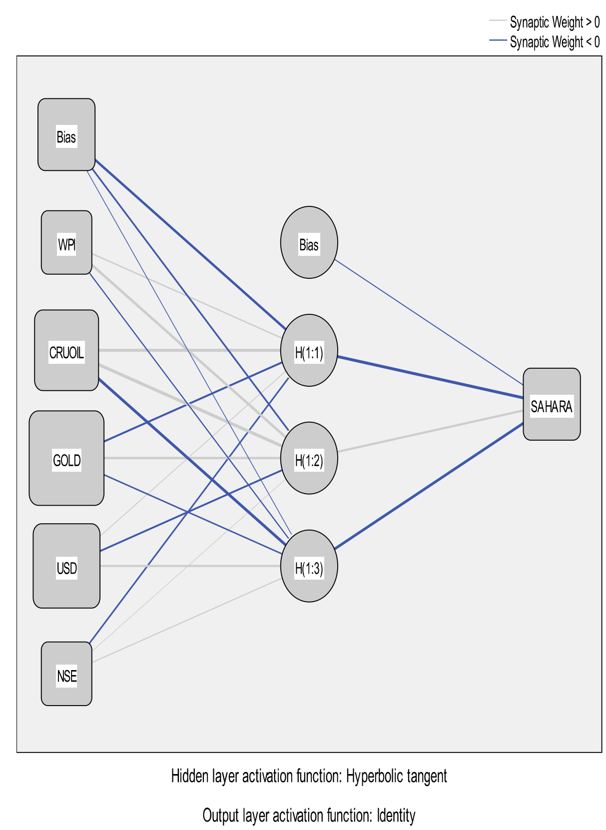

Figure-1. Network diagram.

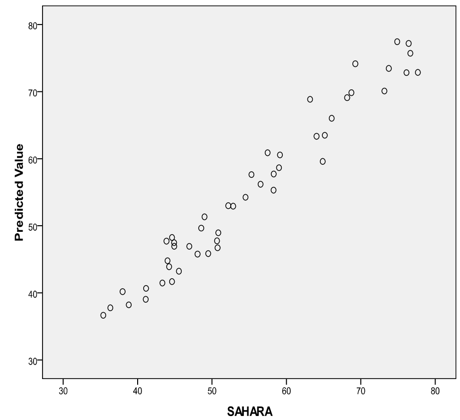

Figure-2. Chart showing actual versus predicted.

6. ARIMA METHODOLOGY

The ARIMA methodology for analyzing and modeling time series is characterized by four steps; (a) Model Identification, (b) Model Estimation, and (c) Diagnostic Testing (d) Forecasting.

a) Model identification

Model identification identifies the (p, d, q) orders of the AR and MA components. In this step, autocorrelation function is the fundamental tool used here. The maximum likelihood, which is asymptotically correct for time series are used to obtain the parameter estimates. Validation of the goodness of fit of an ARIMA model are verified using the following steps:

a) Evaluation of statistical significance of parameters by comparing the parameter value and the standard deviation of its estimate. For an asymptotically valid test, a statistical parameter whose value more than twice its standard error is considered significant.

b) Analysis of the Auto Correlation Function of residuals. In this step, residuals are considered as a new time series for which the Auto Correlation Function and Partial Auto Correlation Function are estimated so that the values at lag k >0 are not statistically different from zero.

b) Model estimation

Having made tentative mode identification, the AR and MA parameters have to be found in the best possible way. There are basically two ways of getting estimates for such parameters.

a) Trial and error - Examine many different combinations of p and q and choose that value that minimizes the sum of squared residuals.

b) Evaluation of statistical significance of parameters by comparing the parameter value and the standard deviation of its estimate. For an asymptotically valid test, a statistical parameter whose value more than twice its standard error is considered significant.

c) Diagnostic testing

For the models obtained, diagnostics tests are performed using (a) Residual ACF (b) Ljung Box test. The residuals (errors) left over after fitting an ARIMA model should be a random noise. Therefore if the autocorrelations and partials of the residuals are obtained, there should not be any significant autocorrelation and partial autocorrelations. For this purpose, the various correlations up to 14 lags were computed and their significance is tested by Box-Ljung test are provided in Table 2. Since these correlations are not significantly different from zero at a reasonable level, the selected ARIMA model is an appropriate model.

d) Forecasting

ARIMA models are developed to forecast the corresponding variable. There are two kinds of forecasts - sample forecasts which develops confidence in the model and post sample forecasts which generates the forecast for the future. Both these kinds of forecasts can be yielded using ARIMA model.

Table-2. Parameter estimation of arima model.

Model ID	Mode l Type	R^2	BI C	Ljung Box Q (18)		
				Statist ics	D.F	Sig
SAHAR A	(0,1,1)	0.91	2.74	9.292	17	0.931

7. DATA ANALYSIS

Table-3. Error estimates for ANN and ARIMA.

ERROR	ANN	ARIMA
MAE	1.9808	2.974
MSE	6.115	13.5634
RMSE	2.473	3.6829
MAPE	3.68	5.527
MPE	-5.883	-0.00641

The monthly averages of several economic variables like the Whole sale price Index (WPI), Crude Oil Rate, Gold Rate, US dollar Rate and NSE Index from 2006 to 2012 were taken as the input variable and the next month NAV of Sahara Mutual Fund-Growth was used as the output for the analysis. The error estimates for the models developed using Artificial Neural Network and Auto Regressive Integrated Moving Average are given in the Table-3.

8. CONCLUSIONS

It can be seen from all the error estimates, Artificial Neural Network model supercedes Auto Regressive Integrated Moving Average model. So it can be concluded that ANN can be effectively used to predict the net asset values for the mutual funds. Since stock market movement and the mutual fund returns follow a non-linear pattern, the advanced nonlinear technique like Artificial Neural Network are better suited for forecasting the net asset value of the mutual fund on the basis of economic variables than the Auto Regressive Integrated Moving Average. The study reaffirms the traditional belief that the economic variables like Whole Sale Price Index (WPI), Crude Oil Rate, Gold Rate, US dollar Rate and NSE Index continue to affect the mutual fund returns in India. Future work can be conducted using the hybrid of ARIMA and ANN and the results can be compared with the individual forecasts.

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