Neural Network Models for Forecasting Mutual Fund Net Asset Value

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Abstract

This paper is an attempt to unravel the relationship between the economic variables and the returns of the mutual funds in Indian context. The paper considers the monthly data of several economic variables like the national output, interest rate, inflation, exchange rate, money supply, aggregate equity market between 1999 and 2004, and tries to reveal the relative influence of these variables on the net asset values of selected mutual fund schemes. Compared to the earlier similar attempts made in the context of developed markets, this paper applies the modern non-linear technique like Artificial Neural Network and tries to predict mutual fund net asset values on the basis of the chosen variables. The finding shows that certain variables like the interest rate, money supply, inflation rate and the equity market have considerable influence in the net asset value movement in the considered period, while the other variables have very negligible impact on the mutual fund returns.
Keywords: Mutual Fund, NAV, Economic Variables, Artificial Neural Network, Forecasting

1. Introduction

Indian capital market has been maturing, of late, with the growing popularity of mutual funds as a tool of investment. With the return from the fixed income instruments touching a bottom and perceived risk present in the equity market, the retail investors are relying more and more towards mutual funds to take care of their investments. What has been observed in the developed economies earlier is now being replicated in India also. There can be little doubt about the growing importance of the mutual funds from the point of view of the aggregate economy. Mutual fund is fast becoming India's investment vehicle of choice. By the end-October, 2004, the total asset managed by all mutual funds has touched Rs. 148283 crores. Indian market has also drawn the attention global investors and the presence of foreign mutual funds and hedge funds has been quite pervasive in the 1990s.

A mutual fund consists of a diversified portfolio of stocks and bonds that are managed by professionally trained individuals. Like portfolios for individual assets, it has provided an opportunity for investors to accommodate risk-return trade-offs as well as diversification, liquidity and tax purposes. Efficient market theory states that all information relevant to an asset will be reflected in its price. In a perfectly efficient market, prices of an asset always reflect all known information, prices adjust instantaneously to new information, and speculation succeeds only as a matter of luck. In an economically efficient market, prices may not react to new information instantaneously, but over the long run speculation can't be rewarded after transaction costs are paid. The hypothesis of efficient market is very popular in the financial literature as documented by Ippolito (1993).

Since mutual funds are diversified portfolios of individual assets, the prices of mutual funds should also reflect the known economic information either instantaneously or over the long run. However, the precise nature of relationship is still unknown to the financial managers and economists. Also it is very difficult to specify a priori relationship between the economic variables and the net asset values of mutual funds. There is a general perception that this inter-relationship between the returns of the mutual funds and the economic variables has been strengthened in India in the recent past. It has been recognized all over the world that the mutual fund net asset value reflects to some extent the goings on in the rest of the economy.

The last 18 months year has been a remarkable period in the Indian capital market. BSE sensitive index, the prime benchmark in India along with nifty in National Stock Exchange, has risen from 3180 at the May, 2003 to around 6000 at the time of writing. The economy is also growing at a faster rate in the current fiscal year. Mutual funds asset mobilsations are also in the upswing as more and more retail and corporate customers are subscribing to their schemes. Keeping all these developments in mind, a necessity has been arisen to test the relationship between the economic variables and mutual funds. To be more precise, the authors felt the need to study the relationship between the net asset values of different types of mutual funds and certain macro economic variables like money supply, industrial production, inflation, interest rate, foreign exchange rate of rupee etc. using modern techniques. The stock market aggregate movement also becomes an influencing variable for mutual funds apart from the economic variables.

During the last three decades there have been some studies on this relationship but almost all of them in the developed economies and most of them used traditional linear techniques for forecasting net asset values by using economic and other variables. There is an acute need to apply more rigorous non-linear techniques as capital market and mutual fund movements are better captured in these methods. Also, there are clearly identified direct beneficiaries of this knowledge. If academicians and practitioners know the precise macro variables that influence the net asset values and also the nature of the relationship then understanding and predicting net asset value would be much simpler with the help of these economic variables. Using this knowledge the investors and fund managers may try to forecast future net asset value of a particular scheme and gain from that knowledge.

2. Review of the Literature

An increasing amount of empirical evidence noticed by several researchers leads to the conclusion that a range of financial and macroeconomic variables can predict stock market returns (for a selection of recent studies see e.g. Campbell, 1987, French, Schwert and Stambaugh, 1987, Fama and French, 1989, Balvers, Cosimano and McDonald, 1990, Been, Glosten and Jaganathan, 1990, Cochrane, 1991, Campbell and Hamao, 1992, Ferson and Harvey, 1993, Glosten, Jaganathan and Runkie, 1993 and Pesaran and Timmerman, 1995, 2000).

Standard stock valuation models predict that stock prices an affected by the discounted value of expected cash flows. Chen et al (1986) and Fama (1990) have shown real economic activity, interest rate and stock returns to be correlated. However, most of these earlier studies focus upon the short-run relationship between stock market and financial and macro-economic variables, which may remove important information contained in the permanent component of economic activity concerning the evolution of short-run movements.

In comparison to the above, long-run relationship between stock market and the economic variables has received little attention of researchers except in Mukherjee, Naka, (1995), Chung & Ng (1998), Maysami and Koh (2000) and Nasseh and Strauss (2000). By using the concept of co integration, first introduced by Eangle and Granger (1987), we can investigate the empirical long run relationships between stock market indices and both measures of economic activity and financial variables. Cointegration between stock prices and economic activity can be seen to be consistent with both internal & theoretical consumption and

production-based asset pricing models. These models suggest that stock prices are related to expected future production through effect on the discounted value of changes in cash flows and dividends (Cochrane).

More recently, empirical models without any specific theoretical structure have been applied in a more pragmatic fashion to the two-way relationship between stock prices and real economic variables. The vector auto-regressive (VAR) model has been particularly popular in this area given that it can be used as a framework for formal examination of inter-relationships within a given data set without the need to specify a theoretical framework a priori.

Recently several researchers like Baestaens et. al. (1995), Kaastra Ibeling and others (1996), Katsurelis (1998), Kamath (1999 and 2002) recommend the use of Artificial Neural Network (ANN) for investigating the co integrating relationship as well as forecasting in capital markets, which has tremendous promise in terms of methodology.

There have been several studies on examining the relationship between the economic variables and the stock market in Indian context. Sharma Kennedy (1977) and Sharma (1983) test the weak-form efficiency of the BSE. Both of these studies with the former covering the 1963-1973 period and the later encompassing the 1973-1971 period, conclude that Indian stocks generally conformed to random-walk behaviour in that successive period changes were independent. Poterba & Summers (1988), however, find evidence of mean reversion in Indian stock prices, suggesting a deviation from random-walk behaviour. Darat & Mukherjee (1987) apply a vector auto regression model (VAR) along with Akaike' s final prediction ever on the Indian data over 1948- 1984 and find that a significant causal relationship (in the sense of Granger, 1969) exists between stock returns and selected macro-economic variables. Naka, Mukherjee and Tufte (1996) have analyzed relationship among selected macro-economic variables and the Indian stock market. By employing a vector error correction model, they find that domestic inflation and domestic output are the two most prominent factors influencing stock prices. In a recent study under NSE Research Initiative Kamath (2002, paper no. 10) uses Artificial Neural Network (ANN) to examine the relationship of macro-economic factors to the returns of individual assets. The BSE Sensex as well as some individual stock has been examined. More recent studies like Bhattacharya & Mukherjee (2002), Rao & Rajeswari (2000), Pethe & Karnik (2000) use advanced methods in econometrics to study the same relationship.

A great number of studies in financial literature have concentrated upon doing the evaluation of the performance of mutual funds. Most of these studies have focused on the forecasting skills of mutual fund managers, which are composed of either forecasts of price movements of selected stocks in the funds (stock selection) or, forecasts of price movements of the general stock market as a whole (market timing). There are no clear-cut results from these studies [see, Chan & Chen (1992), Chang & Lewellen (1984), Chen & Stockum (1986), Kon (1983), Kon & Jen (1979), Lee & Rahman (1991), Treynor & Mazuy (1966) etc]. Most of these studies have used multiple regression techniques as a tool for analysis. In a significant study Chiang, Urban and Baldridge (1996) have used neural network for forecasting the net asset values of the selected mutual funds in U. S. market.

3. Scope of the Study

The objective of the current study is to unravel the linkage between the net asset value of mutual fund and macro economic variables in the Indian context in the post reform-era using advanced technique like Artificial Neural Network (ANN). The period of the study has been chosen as April, 1999-March, 2004. This has been the period where the economic reforms were making an impact on the economy.

In an earlier study, Vani & Ray (2003) try to capture the change in the relationship among macro-economic variables and stock prices over the years. The earlier study uses average yearly data for the period 1971-2002 and chosen macroeconomic variables were Broad Money Supply (M3), Interest Rate (Bank rate), Industrial Activity (Index of industrial production), Inflation (Whole sale price index), Fiscal Deficit, and

GDP. The authors find significant causal relationship between the macro economy and the BSE Sensex movements. Another study by the same authors (Ray & Vani, 2004) focuses more on the post-reform era as it considers the period 1994-2003 and uses monthly data for a larger number of variables from the real economy which should have relationship with the capital market. Not only the domestic economic variables have been considered but the linkage with the external world through the exchange rate movement has also been included in the analysis. The study does not assume any a priori relationship between these variables and the stock market and use both VAR and ANN techniques for this purpose. The study also finds significant causal relationship between the certain macro variables like inflation, interest rate, exchange rate, money supply and stock market movements.

The current study aims to forecast net asset values of different mutual schemes using economic variables, which also influences the capital market in general. For this study, the authors use a completely modern non-linear technique i.e. ANN, which does not need to specify any a priori relationship between the input variables (economic variables) and the target variable (Net Asset Value). The period chosen is April, 1999-March, 2004, considering monthly observations.

4. Selection of Variables, Schemes and Data Collection

Our aim is to detect relationship between economic variables and the net asset value (NAV) of different mutual fund schemes which data is available for a long period. The period we have considered is April, 1999-February, 2004 as the monthly data of all of the variables are available for this period and we can have normalized reliable data for the same period. We have selected 10 schemes (as given in Table I) from the five stars rated schemes by Value Research that represent almost all common categories of mutual fund schemes.

We have chosen the variables following Chen, Roll & Ross (1986) on what they have described as "simple and intuitive financial theory" as there does not appear to exist any theory that accounts for mutual fund price (NAV) movements as a function of micro- and macro- variables. We have selected six economic variables as systematically affecting mutual fund returns (as given in Table II).

We have taken Index of Industrial Production (IP) that reflects the industrial growth in India as the proxy for national output. To measure the money stock in the economy we have taken the most popularly used Broad Money Supply (M3). Since it's difficult to find any benchmark interest rate for the entire time period under study, we have taken the 91-day Treasury Bill Rate (TBR) as the proxy for the interest rate (IR) prevailing in the economy. To account for inflation we have chosen Wholesale Price Index (WPI) with base year as 1993-94. To check the linkage with the external world Rs./$ Exchange Rate (ER) has been taken as another variable. The Sensex of the Bombay Stock Exchange (BSE) is taken as an input variable as it is widely recognized that aggregate market movement is a significant variable for mutual funds

All the data is taken from the Handbook on Statistics (RBI), Economic Survey (Government of India), mutualfundsindia.com and investsmartindia.com. Since the ANN framework does not require any specific model to begin with we have not specified one. However, in testing ANN we have taken NAV as the target variable and others as input variable.

Table: I Input Variables

Symbol	Variable	Definition
NAV	Net Asset Value of a Mutual Fund	Actual Value
BSE	BSE Sensex	(Index with base year as 1978-79 (Monthly Average)
TBR	91-day Treasury Bill Rate	Percentage
WPI	Wholesale Price Index	Index with base year as 1993-94
M	Money Stock represented by M3	Actual Value
IIP	Index of Industrial Production	Index with base year as 1993-94
ER	Monthly Average Rs./$ Exchange Rate	Actual Value (Monthly Average)

Table: II Selected Mutual Fund Schemes

Category	Name of the Mutual Fund Scheme
Debt (Medium Term)	**Alliance Income (G)**
Debt (Medium Term)	**Escorts Income (G)**
Debt (Ultra Short Term)	**Magnum InstaCash Dividend**
Equity Diversified	**Franklin India Prima (G)**
Equity Diversified	**HDFC Equity (G)**
Equity Diversified	**Reliance Growth (G)**
Gilt (Medium & Long Term)	**Kotak Gilt Investment Regular**
Equity Tax Planning	**Franklin India Tax Shield' 95**
Hybrid (Equity Oriented)	**Unit Scheme' 95 (G)**
Hybrid (Debt Oriented)	**Canpremium (Roll Over)**

5. Framework of Artificial Neural Network

An Artificial Neural Network (ANN) is an information processing system that has certain performance characteristics in common with biological neural networks. ANNs are mathematical models of neural biology based upon the assumption that:

1. Information processing occurs at many simple elements called neurons.
2. Signals are passed between neurons over connection links.
3. Each connection link has an associated weight, which multiplies the signal transmitted.
4. Each neuron applies an activation function (usually non linear) to its net input (sum of weighted input signals) to determine its output signal.

ANN is characterized by (1) pattern of connections between the neurons called its **architecture** as shown in fig 1. (2) Method of determining the weights on the connections called training algorithm and (3) activation or transferring function from one neuron to another neuron. Neurons in ANN are organized in single or multi layers. Three layers ANN in fig 1 has input layer with six neurons or nodes, hidden layer with two and output layer has one neuron. Goal of ANN is to learn or discover some association of between input and output variables. This is achieved through modification of weights and transfer function.

The most common applications of ANN in financial research are: (1) for predicting stock performance by classifying stocks into the classes such as stocks with either positive or negative returns and stocks that perform well, neutrally or poorly, (2) for stock price predictions in advance based on previous stock prices and on related financial ratios, (3) the most recent ANN applications in stock market are concerned with modeling stock performance and forecasting.

The current study belongs to third group of ANN application. Considering the factors; Wholesale Price Index, Index of Industrial Production, Money Stock, Monthly Average Exchange Rate, 91-day Treasury Bill Rate and Sensex, NAVs are predicted.

Financial researchers prefer ANN models because of their ability to model non-linear processes with few (if any) a priori assumption about the nature of the process. This is particularly useful in financial engineering applications where much is assumed and little is known about the nature of the processes determining asset prices.

Back Propagation Algorithm is the most commonly used algorithm for developing ANN models for financial data.

5.1 Back Propagation Algorithm (BPA)

Back propagation Algorithm assumes that there is supervision of training of network. The method of adjusting weights is designed to minimize the sum of the squared errors for a given training data set. ANNs are developed by BPA in following steps.

Step 1: Select an input and output variables and decide the architecture of ANN for modeling the variables. x presents the input , y hidden and z output layer.

Step 2: calculate the net inputs and outputs of the hidden layer neurons

$$net_j^h = \sum_{i=1}^{N+1} w_{ji} x_i \qquad y_j = f\left(net_j^h\right)$$

Step 3: calculate the net inputs and outputs of the output layer neurons

$$net_k^0 = \sum_{j=1}^{J+1} v_{kj} y_j \qquad z_k = f\left(net_k^0\right)$$

Step 4: update the weights in the output layer (for all k, j pairs)

$$v_{kj} \longleftarrow\!\!- v_{kj} + c\lambda\left(d_k - z_k\right) z_k \left(1 - z_k\right) y_j$$

Step 5: update the weights in the hidden layer (for all i, j pairs)

$$wji \longleftarrow\!\!- w_{ji} + c\lambda^2 y_j \left(1 - y_j\right) x_i \left(\sum_{k=1}^{k} \left(d_k - z_k\right) z_k \left(1 - z_k\right) v_{kj} \right)$$

Step 6: update the error term

$$E \longleftarrow\!\!- E + \sum_{k=1}^{k} \left(d_k - z_k\right)^2$$

and, repeat from Step 1 until all input patterns have been presented (one iteration.)

Step 7: If E is below some predefined tolerance level (say 0.000001), then stop. Otherwise, reset E=0, and repeat from Step 1 for another iteration.

6. Methodology for Prediction

It is the general perception that mutual net asset value (NAV) is affected by 6 variables like ER, TBR, IIP, WPI, BSE and M as shown in table –II. As these variables are also interrelated, this study attempts to develop the ANN model. This method is widely used for financial modelling. Since this paper attempts to examine past five years period, time series data for the period of April, 1999 to February, 2004 is used for modelling.

ANN model:

For understanding the relationship between NAV and economic variables: BSE, IP, M, ER, WPI and TBR; NN models are developed for each of the schemes separately. For each of the NN models, NAV is considered as output variable (target value) and other variables as input variables. Architecture of NN is as shown in fig. 1 with three layers, input layer (6 nodes), hidden layer (2 nodes) and output layer (1 node). Transfer function used for each of the NN model is sigmoid function, [1/ (1+ exp(-x))]. Data used for the analysis is from April, 1999 to Feb, 2004.

Training data set i.e. data used for developing model consists of 49 points out of 59 and Test data consist of 10 points at random. Test data is given in table -III

Table- IV shows the Network statistics for all the schemes. It can be observed from Table – IV that for all the models developed correlation between actual and predicted values for both training and test data is above 0.9 except Magnum. This indicates that network predictions agree with the actual values reasonably well for all the ten schemes as shown in fig 3.

Considering the standard deviation, it can be seen that maximum is for UTI 95 G for both training and test data as there is high fluctuation as seen in the graph showing all schemes together (see appendix). Otherwise standard deviation is low for both test and training data for all the schemes. Bias in NN measures the shift between actual and predicted values. Again maximum value of bias is –2.11 for UTI otherwise it is a small for rest of all the schemes.

Table-V shows the percentage contribution of input nodes and hidden nodes in the out put node means NAV for each of the schemes under consideration. This helps to identify the influence of input variables which can be further verified by examining the graphs in fig 3 and in fig 4.

Table –VI provides the weights assigned to each of the input variables and hidden nodes. Weights determine the importance of variables to the next node. Weights given in Table-VI indicate the importance of variables in hidden node 1 and 2 as well as importance of each of the hidden node to output node or NAV.

This is discussed further in detail for each of the schemes in the following text.

8.1 ANN analysis for NAV of Each Scheme (Fig 2 & 3)

Alliance: The correlation of 0.997 for training and 0.993 for testing data, Standard Deviation of 0.226 for training and 0.376 for testing data, bias of 0.002 for training and -0.132 for testing data, imply that the predicted values for Alliance agree with actual values very well. As shown in table- V, NN model for Alliance show that M contributes the maximum of 34.89% in determining NAV of Alliance MF where as

WPI contributes 32.44% and TBR contributes 18%. BSE and ER have very negligible contribution 2.73% and 1.62%. Thus major contributory factors are M, WPI and TBR. This is further verified by comparing the time series data in Fig 4. It can be seen that dominating variables, M and WPI have similar pattern as NAV for alliance.

The weights given in table-VI show that hidden node 1 is mainly constituted by M, WPI with negative weight and TBR with positive weight. Hidden node 2 is influenced by M and WPI with positive weight. As result in the final layer, NAV has 61.37 % contribution from hidden node with negative weight of –3.373 where as hidden node 2 have contribution of 38.63 % with negative weight of 2.776.

Escorts : NN model for Escorts also fits well to the data as shown in Table-IV. NAV for escorts is influenced largely by WPI and M. ER and BSE have negligible influence. Hidden node 2, which has contribution of 81.54 % in NAV, is mainly influenced by WPI, M and TBR.

Magnum: Interpreting the results in Table-IV, Table-V and Table-VI in the similar way we can conclude that compared to all other schemes, NN model developed for Magnum is relatively week as correlation for training and test data is low. However 0.843 and 0.719 indicates stronger relationship between actual values and predicted values. Magnum scheme is mainly affected by BSE, WPI and TBR. Hidden node 2 contributes 91.3% in the NAV, which means that it is mainly affected by BSE & TBR with negative weight and M and ER with positive weight.

Franklin G : Conclusion from table-IV and V for Franklin G is that this scheme is highly affected by BSE as much as 40.1%. M has influence of 20.47 % and TBR has 20.86 %. However, in the final output node, contribution of hidden node1 and 2 is 27.02 and 72.98 %.

HDFC G : Unlike earlier schemes examined, NAV of HDFC G has an influence of most of the input variables. However BSE has maximum effect of 30.92%.

Reliance : In the case of Reliance, NAV is affected by BSE by 40.76 % and WPI has minimum effect on NAV. Thus Reliance scheme has been influenced by all the input variables.

Kotak Gilt : Predicted NAV by NN model shown in table IV, V and VI reveal that Kotak Gilt scheme has minimum influence of ER and maximum is of TBR. Unlike, Magnum, Franklin G, HDFC G and Reliance, influence of BSE is much smaller. However predicted values agree with the actual data very well. Hidden node 2 contributes 87.07 % in NAV, which consists of variables IP, M, WPI and TBR with high weight.

Franklin Tax : NAV for Franklin T has very high effect of BSE as shown in table-V where as ER and TBR have marginal effect.

Unit 95 G : TBR affects NAV the maximum as much as by 37.57% where as ER affects the minimum. However hidden node contribution is divided as 26.43 and 73.57 %.

CAN Premium : This scheme has very small effect of IP and ER. Major contributory variables are BSE, M and TBR .

8.2 Financial Significance

The finding that the most influencing variables to the Indian Mutual Fund schemes during 1999-2004 have been the money stock (M), interest rate (TBR), inflation rate (WPI) and aggregate stock market (BSE) is not surprising. Economists and financial researchers have long been suspecting that there should be strong linkages between the capital market and the real economy. However, linear models applied to capture this relationship have failed to do so in Indian context. The recent studies like Bhattacharya & Mukherjee

(2002), Rao & Rajeswari (2000), Pethe & Karnik (2000) have not come out with very strong evidence of linkage although weak forms are visible. Vani & Ray (2003) and Ray & Vani (2004), however, find strong causal relationship between certain macroeconomic variables and the movement of the aggregate stock market. On mutual funds virtually no study is available. The current study, using modern non-linear techniques, has resulted in showing that there is a significant causal relationship between the economic variables and the returns from the mutual funds.

The way the variables individually affects the mutual fund is different. For example, index of industrial production, which has been taken as a proxy of national income, should increase the corporate earnings enhancing the present value of the firm and it also increases the national disposable income, which should lead to more retail investment in the mutual fund. The opposite will cause a fall in the mutual fund returns. The weak causal effect of IIP on NAV, as found out by the study may be explained by the fact that the dominance of the service sector in the Indian economy is not reflected by the IIP.

Interest rates should have a negative relationship with the mutual fund for two reasons: Firstly, the lower the interest rate, the lower the cost of capital for the corporate sector and higher the corporate earnings, which should have a positive influence on the stock prices. Secondly, the lower the interest rate in the fixed income segment, the higher the incentive for the investors to flock to the stock market to get better returns and thus stock market should get a boost. Whenever the individual stock returns are affected or the overall market moves it causes similar movement in the mutual fund returns also. That the interest rate can be a major variable to influence the mutual fund has been captured very well in for the debt and equity oriented schemes. However, the chain of causation is different for both debt and equity schemes. The results show that the interest rate affects the equity oriented schemes more than the debt oriented ones. This study period has seen a drastic fall in the interest rate in the economy, carefully monitored by the Reserve Bank of India, which must have created a favorable impact on the corporate balance-sheet that in turn raises the stock prices.

The effect of the money supply on the mutual fund market is not that obvious. It can operate in two opposite ways. On the one hand, monetary growth, due to its positive relationship with the inflation rate, should adversely affect the stock prices and mutual funs schemes. On the other hand, it may the case that monetary growth brings economic stimulus, resulting in increased corporate earnings and increased stock prices and net asset values for mutual funds. Further, since money supply has an inverse relationship with the interest rate, it should have a positive influence on the stock prices and mutual funds, as there is a negative relationship between the interest rate and stock market. Which effect will the dominating factor at a particular juncture is difficult to predict.

Inflation rate has a positive relationship with the interest rate and hence should affect the stock market adversely. Inflation has a major bearing on the investors' psyche. To cope up with the rising inflation retail investors and other big investors will tend to look towards the stock market and the mutual funds to give their assets a decent real return. This is confirmed from our analysis. However, the plausible effect of the exchange rate on the capital market is not simple to determine. Our study confirms that the exchange rate has very negligible impact on the mutual fund return.

In our study, the aggregate stock movement (BSE) as was taken an input variable in determining net asset value of a mutual fund. It's common knowledge that for equity-oriented schemes the overall market movement should be a crucial factor behind the returns of the mutual funds. From table III, it is very clear that except for the pure debt schemes BSE has played an important role in determining the NAV of the mutual fund schemes. For pure debt oriented schemes, the equity market is quite insignificant which is in conformity with the financial wisdom.

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9. Summary and Conclusion

The current study aims to find out the linkage between the economic variables and the movement of the net asset value of mutual fund. The variables have been chosen carefully to suit the Indian context, namely, index of industrial production (proxy for national output), wholesale price index (proxy for inflation rate), 91-day treasury bill rate (proxy for interest rate), Rs/$ Exchange rate, money stock and aggregate equity market (BSE). On the basis monthly data between April, 1999 and February, 2004, the study attempts to test the influence of these variables on the net asset values of ten pre-selected mutual fund schemes. Since stock market movement and the mutual fund returns follow a non-linear pattern, the study uses advanced non-linear technique like Artificial Neural Network for forecasting the net asset value of the mutual fund on the basis of economic variables.

The study finds that there has been a consistent relationship between certain variables like interest rate, inflation, money supply, equity market and the net asset values of the mutual funds. However, a few variables like exchange rate or the index of industrial production have shown very negligible influence on the net asset values.

The study reconfirms the traditional belief that the economic variables continue to affect the mutual fund returns in the post-reform era in India and also highlights the insignificance of certain variables with respect to mutual fund industry. This has an important lesson for the national policy makers, researchers, corporate managers and regulators.

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Figure 1: ANN Architecture

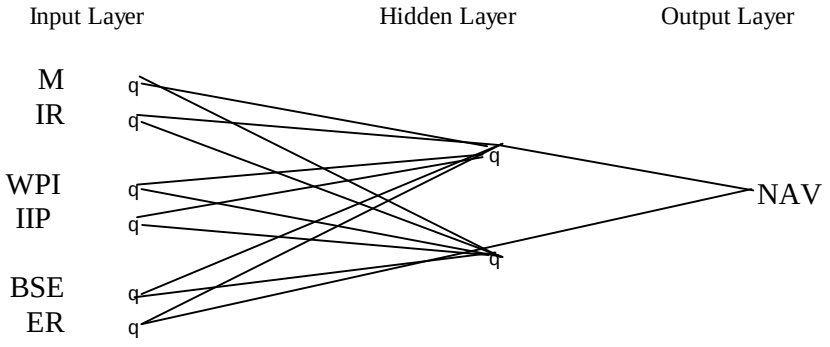


Table III
Testing Data Set

Schemes	
Alliance I	7,15,20,28,34,43,45,47,48,50
Escorts I	4,6,16,28,36,38,43,44,45,55
Magnum	1,8,10,20,22,28,30,37,47,57
Franklin Prima	1,7,8,13,15,25,34,35,53,59
HDFC G	8,9,10,22,29,31,32,37,43,45
Reliance G	1,15,16,19,26,28,37,47,53,54
Kotak Gilt	1,6,10,25,30,36,40,44,49,56
Franklin Tax	9,10,18,27,29,38,42,43,51,55
Unit 95 G	4,10,14,15,19,31,42,44,45,58
Canpremium	1,8,19,21,28,36,38,49,54,55

Table IV
Network Statistics

	Training Data			**Testing Data**		
Schemes	**Correlation**	**Std. Dev.**	**Bias**	**Correlation**	**Std. Dev.**	**Bias**
Alliance	0.997	0.226	0.002	0.993	0.376	-0.132
Escorts I	0.997	0.202	0.002	0.998	0.163	0.026
Magnum	0.843	0.208	0.0002	0.719	0.376	.0099
Franklin G	0.981	2.937	-0.0186	0.986	3.316	-0.530
HDFC G	0.989	1.469	0.0047	.876	1.553	.285
Reliance	0.984	2.77	-.016	.982	2.405	-.661
Kotak Gilt	0.996	.321	-.00195	.998	.3432	.254
Franklin T	0.961	2.384	-.0196	.938	2.916	-.8598
Unit 95 G	0.961	20.11	.019	.99	11.24	-2.11
Canpremium	0.972	.483	-.0029	.96346	.645	.2686

Table V
Percentage Contribution of Nodes

Schemes	**Input Variables**						**Hidden**	
	BSE	IP	MSM	ER	WPI	TBR	1	2
Alliance I	2.73	9.69	34.89	1.62	32.44	18	61.37	38.63
Escorts I	5.11	10.1	32.63	2.01	36.05	14.06	18.46	81.54
Magnum	35.0	3.2	7.11	32.37	4.36	17.94	8.7	91.3
Franklin Prima	40.1	9.74	20.47	7.04	1.79	20.86	27.02	72.98
HDFC G	30.9	6.49	18.03	15.59	10.53	18.44	27.97	72.03
Reliance G	40.7	11.3	21.37	9.85	3.31	13.40	28.10	71.9
Kotak Gilt	7.46	12.8	22.7	0.93	27.7	28.41	12.93	87.07
Franklin Tax	49.2	13.8	14.01	4.66	11.17	7.13	78.67	21.33
Unit 95 G	20.3	9.46	9.55	9.8	13.28	37.57	26.43	73.57

Table VI
Weights Assigned to Nodes

	Input Nodes												Output Node	
	Hidden Node 1						Hidden Node 2						Hidden Node	
Schemes	1	2	3	4	5	6	1	2	3	4	5	6	1	2
	BSE	IP	M	ER	WPI	TBR	BSE	IP	MSM	ER	WPI	TBR		
Alliance	.065	-.432	-1.86	.372	-1.60	1.74	.427	.598	1.354	.455	1.486	.119	-3.37	2.78
Escorts I	-0.28	-.410	-1.09	-.59	-1.441	-0.29	0.28	0.583	1.753	-0.132	1.847	-1.174	3.75	-1.00
Magnum	-1.1	-.911	-.748	0.89	-0.822	0.18	-2.23	0.358	1.130	2.159	0.178	-1.704	-1.57	-2.35
Franklin G	-1.29	-.711	-1.31	-.24	-0.377	0.72	-2.65	-0.509	-1.115	0.904	0.079	1.703	-2.07	-3.73
HDFC G	0.347	-.187	0.30	0.25	0.098	0.30	-2.47	-0.693	-1.575	1.552	-1.001	1.937	0.85	-4.25
Reliance	-1.76	-.62	-1.42	-.06	-.406	0.52	-2.7	-.75	-1.11	1.32	.013	1.19	-2.68	-3.46
Kotak Gilt	0.171	-.034	-0.46	0.04	-0.294	0.11	-0.65	-1.019	-1.653	-0.079	-2.018	2.103	-0.03	-4.26
Franklin T	-3.5	-0.69	-0.35	1.07	-0.181	-0.7	-2.01	-1.189	-1.839	-0.894	-1.540	-0.116	-4.09	-3.69
Unit 95 G	0.814	1.63	0.84	1.22	2.958	-0.10	-3.40	3.111	2.803	2.983	0.623	-6.383	4.43	-4.96
Canprmm	0.364	-0.52	0.72	0.94	0.264	-0.04	-2.04	-0.117	-1.725	0.297	-0.927	2.879	2.12	-4.14

Fig - 2

NAV for Ten Schemes

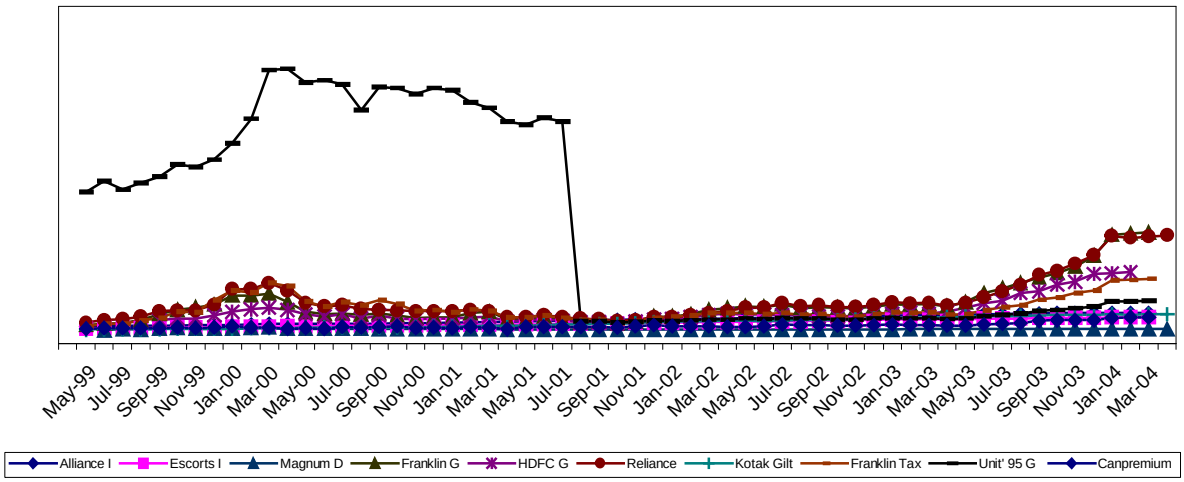
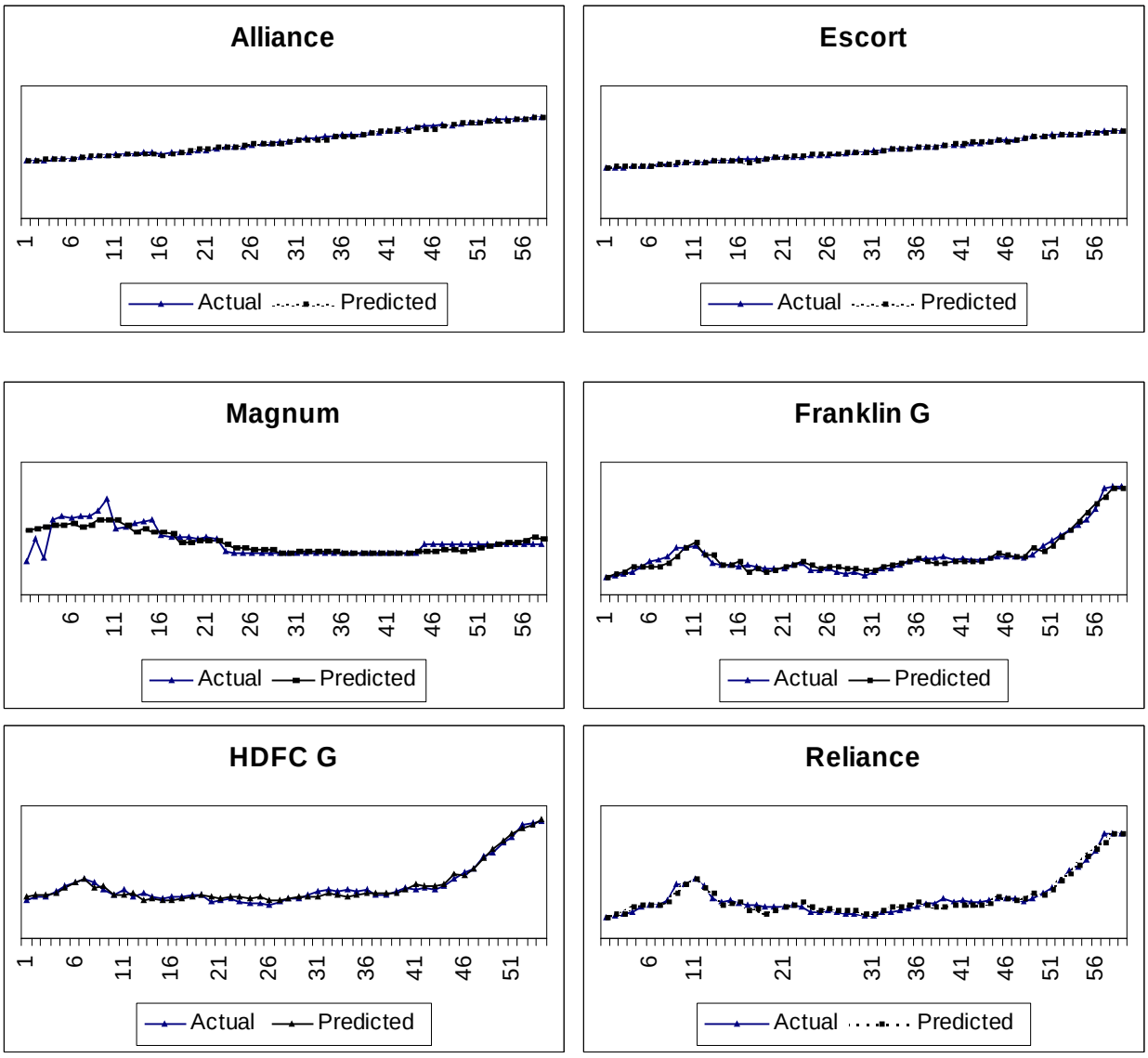
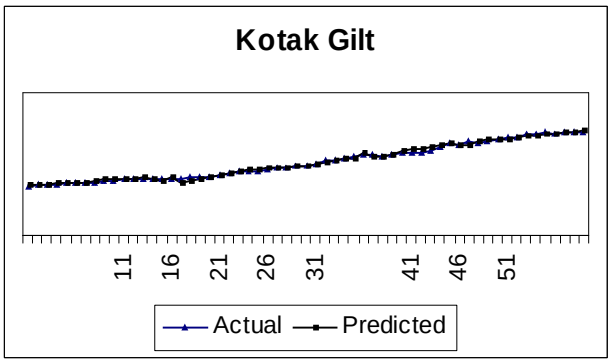
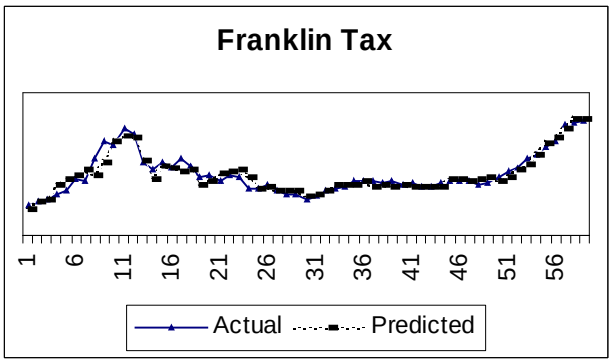


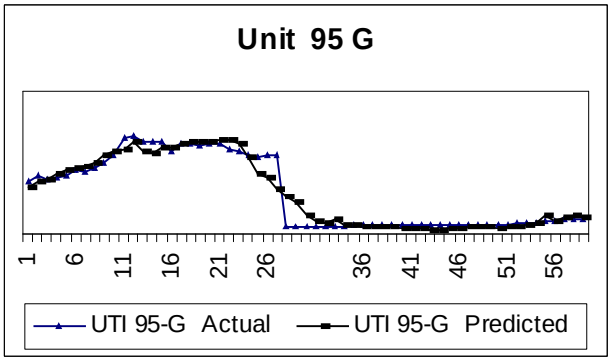
Figure-3

Actual V/S Predicted NAV




Kotak Gilt
11
16
21
26
31
41
46
51
Actual
Predicted


Franklin Tax
1
6
11
16
21
26
31
36
41
46
51
56
Actual
Predicted


Unit 95 G
1
6
11
16
21
26
36
41
46
51
56
UTI 95-G Actual
UTI 95-G Predicted

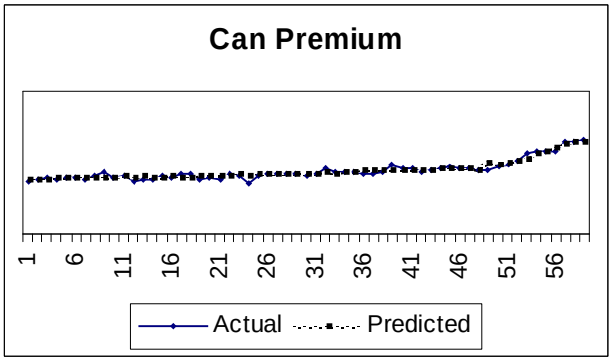

Can Premium
1
6
11
16
21
26
31
36
41
46
51
56
Actual
Predicted

Figure-4

Input Variables