What Moves Indian Stock Market: A Study on the Linkage with Real Economy in the Post-Reform Era

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Abstract

This paper is a fresh attempt to unravel the relationship between the real economic variables and the capital market in Indian context. The paper considers the monthly data of several economic variables like the national output, fiscal deficit, interest rate, inflation, exchange rate, money supply, foreign institutional investment in Indian markets between 1994 and 2003, and tries to reveal the relative influence of these variables on the sensitive index of the Bombay stock exchange. Compared to the earlier similar attempts, this paper applies the modern non-linear technique like VAR and Artificial Neural Network and compares the results. The finding shows that certain variables like the interest rate, output, money supply, inflation rate and the exchange rate has considerable influence in the stock market movement in the considered period, while the other variables have very negligible impact on the stock market.

Keywords: Indian Stock Market, Economic Variables, Artificial Neural Network, VAR

1. Introduction

Indian capital market has undergone tremendous changes since 1991, when the government has adopted liberalization and globalization more seriously than ever before. As a result, there can be little doubt about the growing importance of the stock market from the point of view of the aggregate economy. It has been observed that Indian capital market has been evolved as a major source of raising resources for Indian corporates. Bombay Stock Exchange's (BSE) total market capitalization as a percentage of India's GDP has increased from 4 percent in 1978-79 to around 26 per cent in 2002-03. Indian market has also drawn the attention global investors and the dominance of foreign institutional investors has been quite pervasive in the 1990s.

Not only has the stock market increased relative to the real economy, but also it appears that the inter-relationship between them has strengthened. It has always been recognized all over the world that the stock market reflects to some extent the goings on in the rest of the economy but recently there has been widespread recognition that

the influence is also in the opposite direction—dramatic events in the stock market are likely to have an impact upon the real economy.

The last 6 months have 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. Keeping all these developments in mind, a necessity has been arisen to test the link between the real economy and stock market. To be more precise, the authors felt the need to study the relationship between stock prices and certain real economic variables like money supply, industrial production, inflation, interest rate, fiscal deficit, foreign institutional investment in the capital market, foreign exchange rate of rupee etc. using modern techniques.

During the last three decades there have been many studies on this relationship. However, there is an acute need to apply more rigorous non-linear techniques as stock prices movement is 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 stock prices and also the nature of the relationship then understanding and predicting stock market behavior would be much simpler with the help of these economic variables. Using this knowledge the policy-makers may try to influence the stock market or the investors, managers may make appropriate investment or managerial decisions.

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. Once estimated, the model can be used to simulate the effects of shocks in a way that is consistent with the data by the use of impulse response functions and forecast-error-variance decomposition. A relatively early application of the VAR model to the analysis of the relationship between the stock prices and the macro economy is by Lee (1992) and more recent ones can be found in Cheung and Ng (1998). While the VAR analysis is useful for the simulation of the effects on the endogenous variables of shocks to equation error terms, the non-theoretical nature of such models makes the interpretation of these shocks difficult.

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 this 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. Bhattacharya and Mukherjee (2002) test the causal relationships between the BSE Sensex and five macroeconomic variables applying the techniques of unit-root tests, cointegration and long-run Granger non-causality

test proposed by Toda and Yamamoto (1995). Their major findings are that there are no causal linkage between the stock prices and money supply, national income and interest rate while the index of industrial production leads the stock price and there exists a two-way causation between stock price and rate of inflation. Rao & Rajeswari (2000) try to explore the role being played by a good number of macro economic variables in influencing the stock market when reduced into a manageable number of economic factors. They test the risk-return relationship for individual scrip for the 1995-2000 period using the traditional CAPM, three-factor macro economic factor model and the five-factor APT. Pethe and Karnik (2000) use unit-root, co-integration and error-correction models to test relationship between stock market behavior and some macro-economic variables.

3. Scope of the Study

The objective of the current study is to unravel the linkage between the stock market movement and real economic events in the Indian context in the post reform-era using advanced techniques like VAR and ANN. The period of the study has been chosen as April, 1994-March, 2003. 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 author found significant causal relationship between the macro economy and the BSE Sensex movements. The present study is more focused 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 is open to the possible two-way relationship between them. Both VAR and ANN are suitable techniques for this purpose. The study aims to reveal with more precision the major influencing variables of the Indian capital market in the post-reform era.

4. Selection of Variables and Data Collection

Our aim is to detect relationship between real economic variables and the Sensitive Index (Sensex) Bombay Stock Exchange, India's premier stock exchange for which data is available for a long period. The period we have chosen is April, 1994-March, 2003 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 as many of the indices like Wholesale Price Index or Index of Industrial Production have their base as 1993-94. 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 stock price (BSE) movements as a function of micro- and

macro-indices. We have selected seven non-equity-related real economic variables as systematically affecting stock returns (as given in Table 1).

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 SBI Prime Lending Rate (SBIPLR) 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. Indian economy has some unique features since Government account has a very prominent role in the economy. To capture this in our model we have taken fiscal deficit (D) as a macro variable affecting the stock prices. To test the common perception that the FII has been a driver to the stock market in India we have included Foreign Institutional Investment in Indian capital market (FII) as another crucial economic variable. To check the linkage with the external world Rs./$ Exchange Rate (ER) has been taken as another variable. All the data is taken from the Handbook on Statistics (RBI) and Economic Survey (Government of India). Since the both VAR and ANN framework does not require any specific model to begin with we have not specified one. However, in testing ANN we have taken BSE as the target variable and others as input variable.

Table:1

Symbol	Variable	Definition
BSE	BSE Sensex	(Index with base year as 1978-79 (Monthly Average)
IR	SBI Prime Lending 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
FD	Fiscal Deficit of the Central Government	Actual Value
FII	Foreign Institutional Investment in Capital Market	Actual Value
ER	Monthly Average Rs./$ Exchange Rate	Actual Value (Monthly Average)

5. Framework of Artificial Neural Network

Artificial Neural Networks (ANN) are adaptive statistical models based on analogy with the structure of brain. ANNs are built from simple units called neurons by analogy. These units are interlinked by a set of weighted connections and are organized in layers namely; input layer, hidden layer/s and output layer as shown in fig. 1. Thus goal of ANN is to learn or to discover some association between input and output variables. This learning process is achieved through modification of the connection weights between units.

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, Fiscal deficit, Money Stock, Monthly Average Exchange Rate, SBI Advance Rate and Foreign Institutional Investment in capital market, Stock prices are predicted.

ANN models are preferred by financial researchers because of their ability to model non-linear processes with few (if any) 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)

Having decided the architecture of ANN, input variables and output / target variable, BPA is as in following steps:

Step 1: randomly select an input pattern x to present to the ANN through the input layer.
Step 2: calculate the net inputs and outputs of the hidden layer neurons

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

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 epoch).
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 epoch.

6. Framework of VAR

VAR is an extension of univariate auto regression model. VAR is commonly used for forecasting system of interrelated time-series and for analyzing the dynamic impact of random disturbances on the system of variables.

Mathematical form of VAR is

$$y_t = A_1 y_{t-1} + ... + A_p y_{t-p} + E_t$$

y_t : k × 1 vector of endogenous variables
$A_1 \ldots Ap$ is matrices to be estimated
E_t is a vector of innovations

Each of the equations is like univariate autoregressive model but in addition, it includes lagged values of the other variables.

Suppose, macro-economic variables, BSE, FII, FD, ER, WPI, IR, IIP and M are interrelated. Modelling each series separately might involve an auto regression of each of these variables. However, such separate approach will not capture any interaction between the variables that might be present. VAR modelling of these variables involve equations for each of the variables. Consider the variable BSE, which is related not only its own lagged values but also of other seven variables. These equations are shown in exhibit V.
Thus, VAR has two dimensions the length of the longest lag in auto regression and k number of variables being jointly modeled.

7. Methodology for Prediction

It is the general perception that Indian stock market (BSE) is affected by 7 economic variables like ER, FD, FII, IR, IIP, WPI and M as shown in table – I. As these variables are also interrelated, this study attempts to develop VAR models and ANN models. Both of these methods are widely used for financial modelling. Since this paper attempts to examine post reform era in Indian stock market, time series data for the period of April 1994 to March 2003 is used for modelling.

VAR Models:

All eight variables listed in table – I are considered as endogenous variables for VAR models with assumptions that all these variables are interrelated. We assume that constant is the only exogenous variable. Using the software, Eviews, VAR models are developed as shown in exhibit-IV and V.

Exhibit-IV shows VAR estimates and Exhibit-V models for all 8 variables. Figure-2 indicates the actual and estimated values of BSE. It can be noted that this does not capture the volatility of BSE.

R^2 statistics for 8 models in exhibit-IV reveal that FII and FD equations explain data only 46.6% and 30.7% only where as models for other variables more than 86%.

ANN model:

Various ANN modes considering, BSE as a target variable and the rest of as input variables were developed for the architecture shown in Figure 1.

NN models were developed for the same architecture, using various transfer functions such as; Gaussian, Sigmoid, Tanh and Sech. Out of 108 monthly data points for the period of April 1998 to march 2001, 98 points were used for developing model and 10 points at random were used for testing the models. Considering volatility in data, especially during the period of December 1998 to September 2001, it was decided to test the model for random points to understand the contributions of variables for the entire period. Comparing the error and correlation between actual and predicted values, it was concluded that Tanh was the best ANN model. Results of which are shown in exhibits-I to III.

Exhibit-I shows correlation between actual and predicted values for training data as 0.84 and for test data 0.856. Exhibit-II shows the contribution of input variable and Exhibit –III shows the connection weight between the nodes. It can be seen that weights for FD, and FII are very small for both the hidden nodes. Thus, once again weightage of these variables is relatively much smaller compared to other variables.

The same analysis has been done for the period December, 1998- September, 2001, because during this period BSE shot up and came down and remained more or so the same level before December 1998. The current study attempts to find out the role of the economic variables on BSE during this period. Findings are shown in Exhibit-II(b). It can be seen that contribution of M is reduced and contribution of FD and FII are marginally improved along with IR and ER. However, overall effect of FD and FII on BSE is negligible.

8.1 ANN and VAR analysis for Stock Market

The above results conclude that the stock market has been affected by the variables, ER, IIP, M, IR and WPI. Further, comparing coefficients (weights) in model for BSE in Exhibit-IV and V reveal that coefficient for FD, FII and M are very small for both the lag period where as for other variables have much higher values, which means more weightage in determination of BSE. Comparing shock to BSE in fig 4 and 5 also indicates that shock to BSE in the case of FII, FD and M is very flat. This also reveals that BSE has least effect of these variables. Fig 2 for actual values of BSE and estimated BSE by VAR method indicate that volatility of BSE is not captured.

Comparing ANN models and VAR models for this data reveal that ANN models perform better as they capture volatility of BSE. However, both the models reveal that FD and FII have least impact on BSE. Impact of M keeps changing at different periods.

Further analysis of data for the period of December, 1998-February, 2000 reveals that the money stock contributed 45.03 % of BSE's movement, which can be interpreted as that the money stock has primarily been responsible for the shooting up of BSE. Analysis of the data between February, 2000 and September 2001 reveal that the highest contribution in BSE for this period has been 31.35 % of IR and marginally better contribution of FD and FII has been observed.

This concludes that overall contribution of FII and FD in BSE is not very significant. However during short periods, marginally improvements along with other variables may cause the fluctuations.

8.2 Financial Significance

The knowledge that the most influencing variables to the Indian Stock Market during 1994-2003 have been the exchange rate**,** index of industrial production (IIP), money stock (M), interest rate (IR) and inflation rate (WPI), 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. The current study, using two modern non-linear techniques, has resulted in showing that there is a significant causal relationship between the real economic variables and the capital market.

The way the variables individually affects the stock market 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 stock market. The opposite will cause a fall in the stock market. Interest rates should have a negative relationship with the stock market 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. That the interest rate can be a major variable to influence the stock market has been captured very well in the period February, 2000 to September, 2001. This 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 favourable impact on the corporate balance-sheet that in turn raises the stock prices.

The effect of the money supply on the stock 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. On the other hand, it may the case that monetary growth brings economic stimulus, resulting in increased corporate earnings and increased stock prices. Further, since money supply has an inverse relationship with the interest rate, it should have a positive influence on the stock prices 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. But at times, money stock has been the dominant influencing variable to the stock market has been evidenced by the movement between December, 1998 and February, 2000. The period considered has seen a rapid increase in money supply preceding that, which confirms the positive influence of money supply on the stock market in this period.

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 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. A fall in the exchange rate should lead to more exports and more foreign exchange into the economy, which will increase the money supply and inflation in the economy. Since the period of the current study precludes the last one year period when the exchange rate of Ruppee vis. a. vis Dollar has decreased, we can safely say that the above channel might have operated in this case also.

The most surprising result of the study is the finding that the foreign institutional investment has been a very insignificant factor in moving the stock market, which is contrary to the common perception that it, is the foreign portfolio investment that moves the stock market. The finding is a reassurance for domestic market's strength and becomes a crucial input for our policy makers as well as the regulators. Another variable whose influence has been the minimum is the fiscal deficit. In the 1980s and early 1990s fiscal deficit used to cast a huge influence on the economy by crowding out private investment. Now the financial system is flush with money and the crowding out effect has been lost its relevance. This knowledge is again a very important input for our policy makers.

9. Summary and Conclusion

The current study aims to find out the linkage between the real economic variables and the movement of the stock market. 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), SBI prime lending rate (proxy for interest rate), Rs/$ Exchange rate, foreign institutional investment in Indian capital market, fiscal deficit and money stock. On the basis monthly data between April, 1994 and March, 2003, the study attempts to test the influence of these variables on the sensitive index of Bombay Stock Exchange. Since stock market movement follows a non-linear pattern, the study uses advanced non-linear technique like Artificial Neural Networks and Vector Auto Regressive models and compares the results.

Although there have been some periods of fluctuations there has been a consistent relationship between certain variables like exchange rate, interest rate, index of industrial production, inflation and money supply and the stock market and both models confirm the analysis. However, a few variables like fiscal deficit or the foreign institutional investment in the capital market have shown very negligible

influence on the stock market. In brief period like those between December, 1998-February, 2000 and February, 200-September, 2001 a single variable like the money supply or the inflation rate becomes the dominant influencing variable to the stock market respectively.

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

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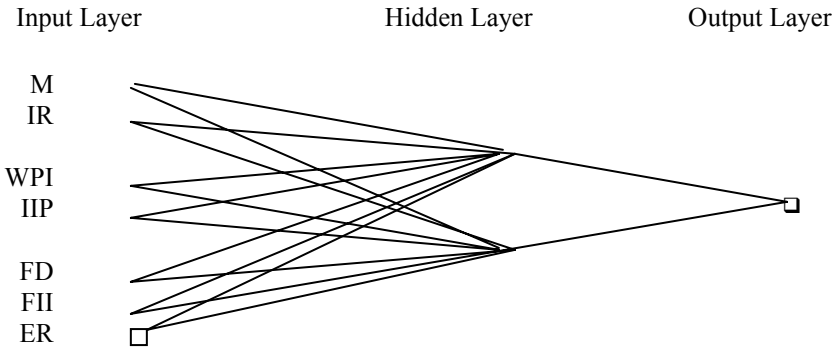

Figure 1

Exhibit 1

Network statistics				
	Std. Dev	**Bias**	**Max Error**	**Correlation**
Training Data	**307.157**	**-1.69**	**86.29**	**0.844**
Test Data	**387.09**	**11.72**	**748.83**	**0.856**

Exhibit-II (a)
Average Contribution of Nodes on Output

Layer	**Node**	**% Contribution**
1	**FD**	**3.22**
1	**IP**	**14.70**
1	**MONEY**	**17.90**
1	**EXR**	**20.41**
1	**WPI**	**21.42**
1	**SBIR**	**21.80**
1	**FII**	**0.55**
2	**1**	**63.86**
2	**2**	**36.14**

Exhibit-II(b)
Average Contribution of Nodes on Output
For Dec 98 to Sept 01

Layer	Node	% Contribution
1	FD	6.75
1	IP	12.65
1	MONEY	6.81
1	EXR	24.38
1	WPI	20.09
1	SBIR	24.87
1	FII	4.48
2	1	33.83
2	2	66.17

Exhibit-III

Network Weights and Current Adjustment Deltas

Layer	Node	Connection	Weight
Hidden	1	FD	0.66348
Hidden	1	IP	-1.38305
Hidden	1	MONEY	-2.68420
Hidden	1	EXR	-0.04913
Hidden	1	SBIR	-2.12530
Hidden	1	FII	3.27978
Hidden	1	BIAS	0.18084
Hidden	1	FD	4.15708
Hidden	2	IP	0.45237
Hidden	2	MONEY	-1.65861
Hidden	2	EXR	2.19203
Hidden	2	SBIR	3.12719
Hidden	2	FII	2.58667
Hidden	2	BIAS	4.06987
Hidden	2	FD	-0.00355
Hidden	2	IP	-2.11629
Output	1	MONEY	3.16270
Output	1	EXR	-4.71286
Output	1	SBIR	0.82227

Exhibit-IV

Estimates for VAR models

Standard errors & t-statistics in parentheses

	BSE	EXR	FD	FII	IP	MONEY	SBIR	WPI
BSE(-1)	0.886	0.000	-1.029	-0.139	0.001	31.933	0.000	0.0(
	-0.108	0.000	-2.418	-0.332	-0.002	-54.161	0.000	0.000
	-8.203	(-0.92549)	(-0.42576)	(-0.41845)	-0.358	-0.590	(-0.80262)	-0.800
BSE(-2)	-0.039	0.000	-1.816	0.348	0.000	-36.953	0.000	0.000
	-0.107	0.000	-2.404	-0.330	-0.002	-53.838	0.000	0.000
	(-0.36239)	-2.156	(-0.75570)	-1.053	-0.087	(-0.68638)	-0.099	(-0.26863)
EXR(-1)	11.719	1.086	-259.266	-246.619	-0.295	-10016.390	0.174	0.102
	-52.940	-0.100	-1185.730	-162.796	-1.199	-26559.900	-0.056	-0.165
	-0.221	-10.871	(-0.21865)	(-1.51490)	(-0.24564)	(-0.37712)	-3.097	-0.619
EXR(-2)	6.300	-0.179	867.812	223.019	0.418	15531.190	-0.256	-0.168
	-54.489	-0.103	-1220.420	-167.559	-1.234	-27336.900	-0.058	-0.170
	-0.116	(-1.74292)	-0.711	-1.331	-0.339	-0.568	(-4.43290)	(-0.98625)
FD(-1)	-0.001	0.000	-0.264	0.036	0.000	0.141	0.000	0.000
	-0.005	0.000	-0.101	-0.014	0.000	-2.257	0.000	0.000
	(-0.25432)	-0.989	(-2.62094)	-2.587	(-2.94701)	-0.063	(-0.57490)	-1.000
FD(-2)	-0.001	0.000	0.215	-0.026	0.000	3.619	0.000	0.000
	-0.005	0.000	-0.103	-0.014	0.000	-2.318	0.000	0.000
	(-0.10952)	-1.089	-2.079	(-1.84137)	-0.962	-1.561	(-0.47743)	-1.414
FII(-1)	0.010	0.000	0.015	0.212	0.001	9.260	0.000	0.000
	-0.035	0.000	-0.783	-0.108	-0.001	-17.541	0.000	0.000
	-0.286	(-1.80555)	-0.019	-1.973	-0.795	-0.528	-0.762	(-0.70491)
FII(-2)	0.037	0.000	0.907	-0.105	-0.003	-1.198	0.000	0.000
	-0.033	0.000	-0.739	-0.102	-0.001	-16.564	0.000	0.000
	-1.115	(-0.14857)	-1.227	(-1.03189)	(-3.44867)	(-0.07230)	(-0.89145)	-0.772
IP(-1)	3.445	-0.003	233.851	18.219	0.422	1599.364	-0.013	0.029
	-4.480	-0.008	-100.343	-13.777	-0.102	-2247.640	-0.005	-0.014
	-0.769	(-0.31970)	-2.331	-1.322	-4.153	-0.712	(-2.81122)	-2.046
IP(-2)	1.826	-0.005	215.091	9.628	0.358	-1631.289	0.008	-0.008
	-4.836	-0.009	-108.320	-14.872	-0.110	-2426.310	-0.005	-0.015
	-0.378	(-0.51116)	-1.986	-0.647	-3.263	(-0.67233)	-1.478	(-0.52747)
MONEY(-1)	0.000	0.000	0.008	0.000	0.000	0.066	0.000	0.000
	0.000	0.000	-0.005	-0.001	0.000	-0.104	0.000	0.000
	(-1.14622)	(-0.37931)	-1.654	-0.158	(-1.58634)	-0.641	-0.394	-2.328
MONEY(-2)	0.000	0.000	-0.009	-0.001	0.000	0.160	0.000	0.000
	0.000	0.000	-0.005	-0.001	0.000	-0.108	0.000	0.000
	-0.541	(-0.24108)	(-1.90081)	(-0.96382)	-0.132	-1.479	(-0.03702)	-0.895
SBIR(-1)	-93.866	-0.242	2249.596	164.916	1.189	-5863.098	0.864	0.070
	-91.017	-0.172	-2038.550	-279.884	-2.062	-45662.700	-0.096	-0.284
	(-1.03131)	(-1.41071)	-1.104	-0.589	-0.577	(-0.12840)	-8.952	-0.245
SBIR(-2)	1.553	0.334	-3083.481	-15.195	-0.469	-6743.153	-0.068	-0.239
	-90.299	-0.170	-2022.480	-277.677	-2.046	-45302.600	-0.096	-0.282
	-0.017	-1.960	(-1.52461)	(-0.05472)	(-0.22942)	(-0.14885)	(-0.71428)	(-0.84688)
WPI(-1)	-102.007	-0.079	129.371	-34.055	-1.275	18109.100	-0.062	1.157

	-36.216	-0.068	-811.159	-111.368	-0.821	-18169.600	-0.038	-0.113
	(-2.81661)	(-1.15273)	-0.159	(-0.30579)	(-1.55414)	-0.997	(-1.61025)	-10.226
WPI(-2)	82.117	0.129	-775.213	30.536	1.722	-5815.378	0.076	-0.224
	-35.797	-0.068	-801.771	-110.080	-0.811	-17959.300	-0.038	-0.112
	-2.294	-1.906	(-0.96688)	-0.277	-2.124	(-0.32381)	-1.990	(-2.00379)
C	3234.572	-3.953	31885.700	-4434.405	-37.997	-1049000.000	5.192	8.829
	-1500.540	-2.831	-33608.400	-4614.280	-33.995	-752813.000	-1.590	-4.687
	-2.156	(-1.39631)	-0.949	(-0.96102)	(-1.11773)	(-1.39344)	-3.265	-1.884
R-squared	0.867	0.995	0.466	0.307	0.950	0.914	0.984	0.998
Adj. R-squared	0.843	0.995	0.370	0.183	0.941	0.898	0.981	0.998
S.E. equation	235.751	0.445	5280.261	724.956	5.341	118275.500	0.250	0.736
F-statistic	36.121	1187.655	4.851	2.466	105.905	58.978	344.850	3601.467

Exhibit-V

SIGN @ALL F

BSE = 0.8855127801*BSE(-1) - 0.03888807982*BSE(-2) + 11.71899144*EXR(-1) + 6.299537139*EXR(-2) - 0.001144084359*FD(-1) - 0.0005060070069*FD(-2) + 0.01000002316*FII(-1) + 0.03680463195*FII(-2) + 3.445062833*IP(-1) + 1.825901541*IP(-2) - 0.0002365633214*MONEY(-1) + 0.0001166215955*MONEY(-2) - 93.86639796*SBIR(-1) + 1.553310765*SBIR(-2) - 102.0074002*WPI(-1) + 82.11698981*WPI(-2) + 3234.571806

EXR = - 0.000188479081*BSE(-1) + 0.0004365387583*BSE(-2) + 1.085721924*EXR(-1) - 0.1791566717*EXR(-2) + 8.396818744e-06*FD(-1) + 9.490757884e-06*FD(-2) - 0.0001190880738*FII(-1) - 9.25330051e-06*FII(-2) - 0.002701908332*IP(-1) - 0.004663461555*IP(-2) - 1.476802862e-07*MONEY(-1) - 9.812583877e-08*MONEY(-2) - 0.2422177006*SBIR(-1) + 0.3338724588*SBIR(-2) - 0.07875513048*WPI(-1) + 0.1286914102*WPI(-2) - 3.952534717

FD = - 1.029469003*BSE(-1) - 1.816337111*BSE(-2) - 259.2660274*EXR(-1) + 867.811554*EXR(-2) - 0.2640824678*FD(-1) + 0.2151003654*FD(-2) + 0.01494881881*FII(-1) + 0.9072359123*FII(-2) + 233.8510278*IP(-1) + 215.0912752*IP(-2) + 0.007644317441*MONEY(-1) - 0.009185868902*MONEY(-2) + 2249.596494*SBIR(-1) - 3083.480853*SBIR(-2) + 129.3709391*WPI(-1) - 775.2127543*WPI(-2) + 31885.70315

FII = - 0.1389139674*BSE(-1) + 0.3475469245*BSE(-2) - 246.6193342*EXR(-1) + 223.0185075*EXR(-2) + 0.03578171062*FD(-1) - 0.02616071225*FD(-2) + 0.2121087782*FII(-1) - 0.1047645655*FII(-2) + 18.21923049*IP(-1) + 9.628009058*IP(-2) + 0.0001001853788*MONEY(-1) - 0.0006394893234*MONEY(-2) + 164.9155767*SBIR(-1) - 15.19494928*SBIR(-2) - 34.05520555*WPI(-1) + 30.53561326*WPI(-2) - 4434.404885

IP = 0.0008753721233*BSE(-1) + 0.0002120100724*BSE(-2) - 0.2946198739*EXR(-1) + 0.4181751844*EXR(-2) - 0.0003003551852*FD(-1) + 0.0001006669318*FD(-2)

+ 0.0006296093401*FII(-1) - 0.002579580129*FII(-2) + 0.4215666861*IP(-1) + 0.3575433324*IP(-2) - 7.417331387e-06*MONEY(-1) + 6.449040825e-07*MONEY(-2) + 1.189056498*SBIR(-1) - 0.469340342*SBIR(-2) - 1.275165478*WPI(-1) + 1.722320717*WPI(-2) - 37.99748068

MONEY = 31.93328818*BSE(-1) - 36.95305144*BSE(-2) - 10016.3883*EXR(-1) + 15531.18847*EXR(-2) + 0.141384382*FD(-1) + 3.618700918*FD(-2) + 9.260047142*FII(-1) - 1.197575113*FII(-2) + 1599.36379*IP(-1) - 1631.28862*IP(-2) + 0.06633646035*MONEY(-1) + 0.1601107379*MONEY(-2) - 5863.097547*SBIR(-1) - 6743.152522*SBIR(-2) + 18109.10341*WPI(-1) - 5815.378284*WPI(-2) - 1048999.882

SBIR = - 9.183301651e-05*BSE(-1) + 1.128526118e-05*BSE(-2) + 0.1737836933*EXR(-1) - 0.256001057*EXR(-2) - 2.741065328e-06*FD(-1) - 2.337800502e-06*FD(-2) + 2.825483448e-05*FII(-1) - 3.119381247e-05*FII(-2) - 0.01334831152*IP(-1) + 0.007574377259*IP(-2) + 8.626776853e-08*MONEY(-1) - 8.466449647e-09*MONEY(-2) + 0.8635642964*SBIR(-1) - 0.06835922885*SBIR(-2) - 0.06180785609*WPI(-1) + 0.07550500695*WPI(-2) + 5.191959611

WPI = 0.0002696243824*BSE(-1) - 9.004918726e-05*BSE(-2) + 0.1023149581*EXR(-1) - 0.1678707171*EXR(-2) + 1.40459257e-05*FD(-1) + 2.040853375e-05*FD(-2) - 7.698902426e-05*FII(-1) + 7.964454857e-05*FII(-2) + 0.02863635922*IP(-1) - 0.007968634948*IP(-2) + 1.500913726e-06*MONEY(-1) + 6.032170291e-07*MONEY(-2) + 0.06968292095*SBIR(-1) - 0.2388828933*SBIR(-2) + 1.156895512*WPI(-1) - 0.2240685766*WPI(-2) + 8.828959254

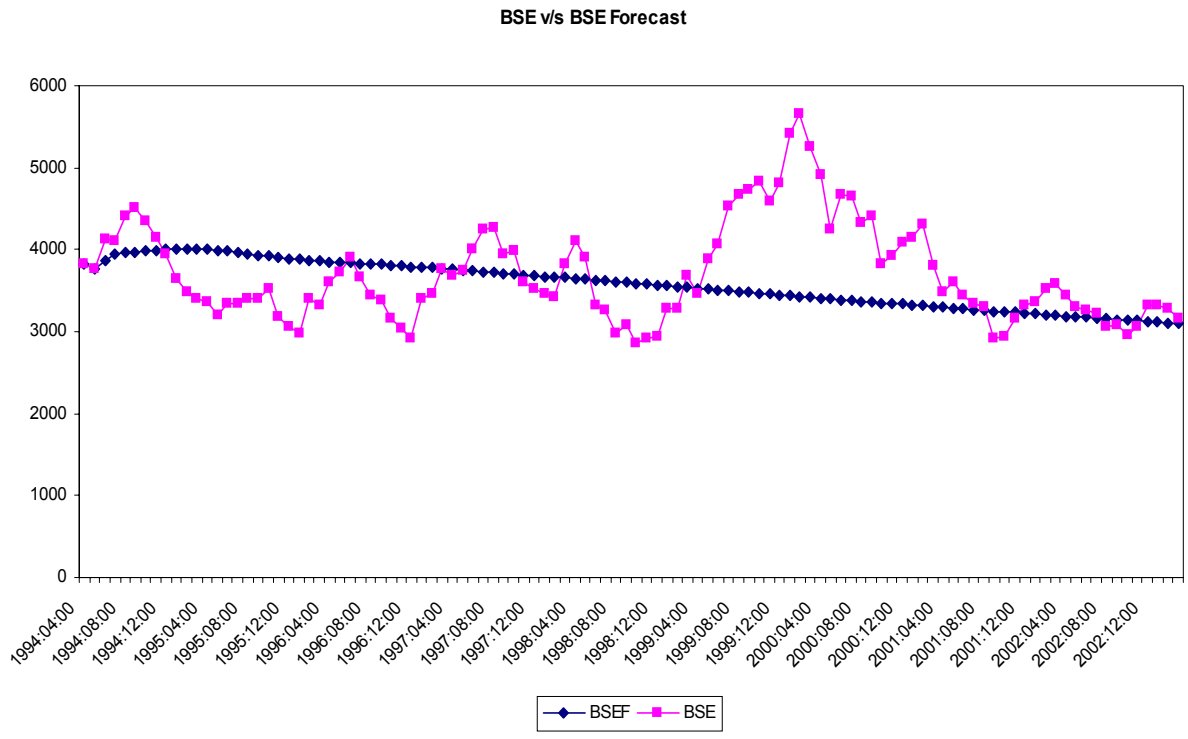

Figure 2

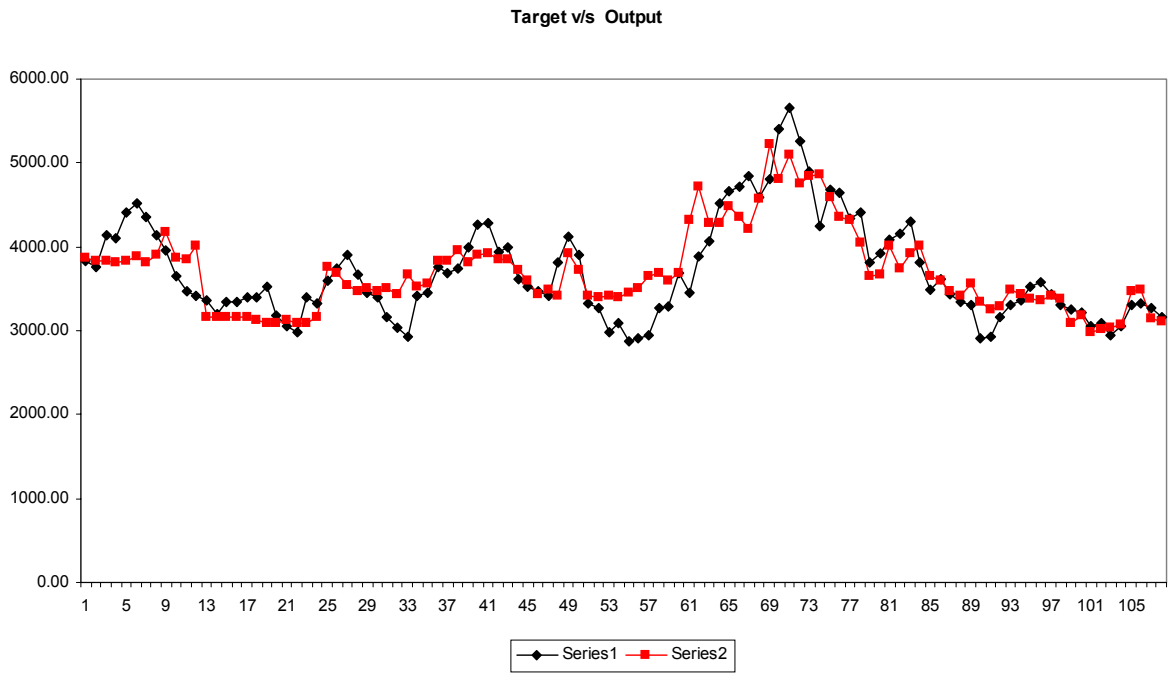

Figure 3

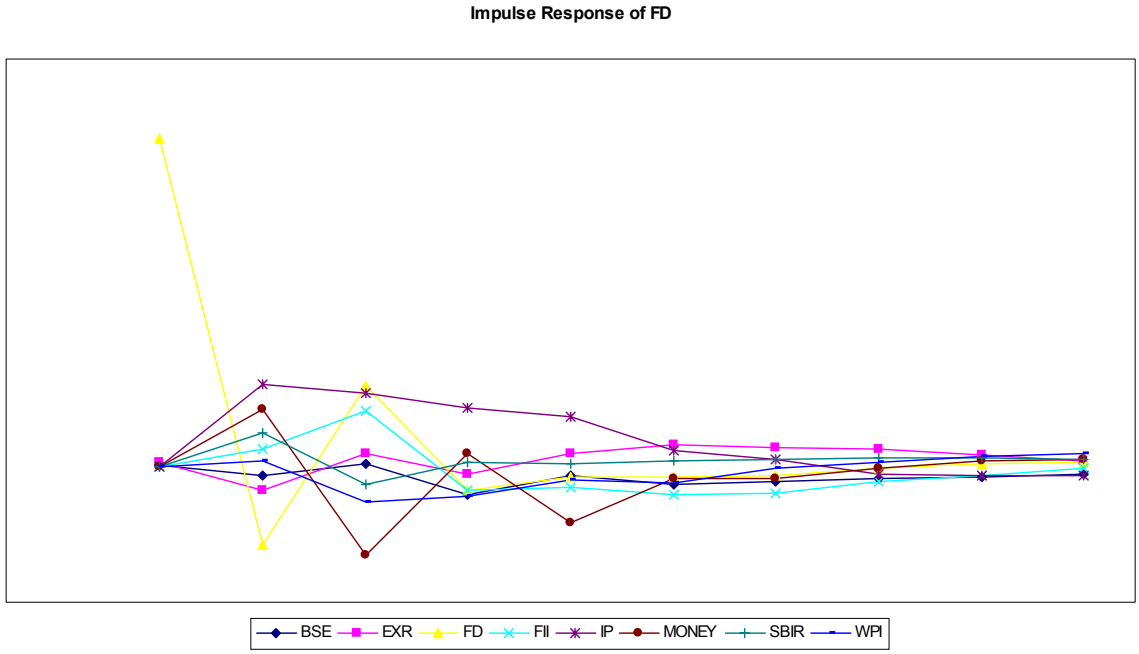

Figure 4

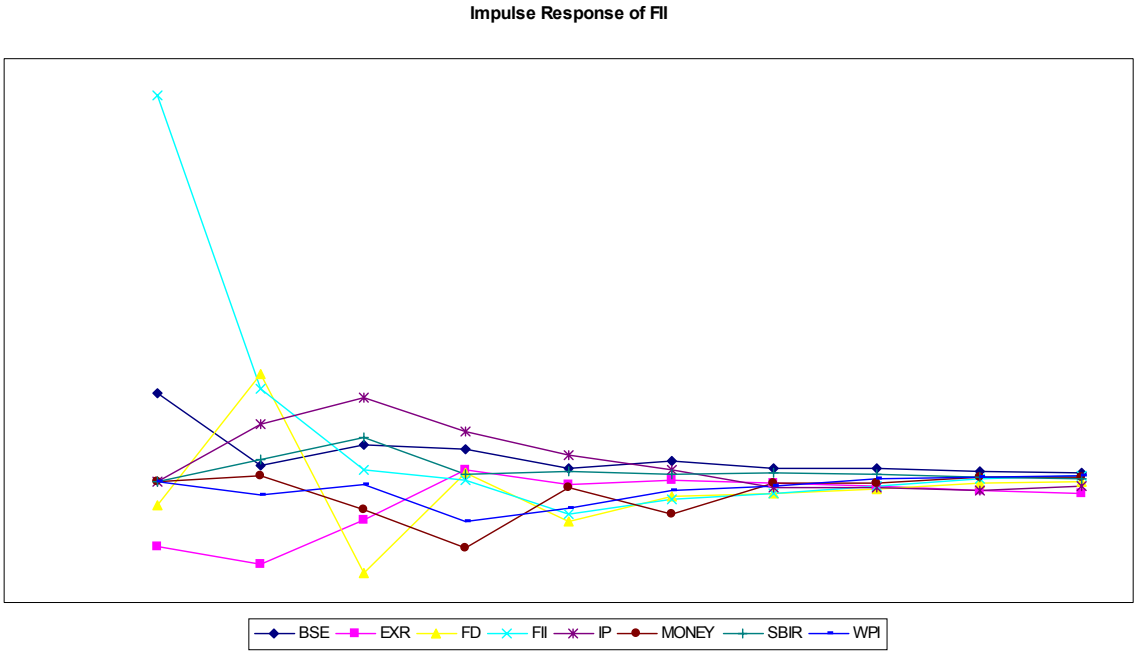

Figure 5