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Forecasting Credit Lending Viability for ICICI Bank applying Back Propagation Neural Network.

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Abstract

There has always been a need of an early warning signal of bankruptcy before the bankruptcy befalls any firm in particular. If this could happen it would in turn brighten the prospects of occurrence of bankruptcy in particular. the paper first surveys the existing literature for various techniques that have been developed to assess credit risks including the credit scoring models and quantitative models pioneer the by researchers that talk about the non-payment capacity of borrowers and the non accuracy on part of recovery of credit. Thereafter, this paper makes use of tailored back-propagation neural network to predict the financial ratios that formulate the credit viability of the borrowing firms. It first computes financial ratios using the basic formulas for a firm from 2001-2008.these computed ratios are used to the train the BPNN. Finally it dwells to draw predictions for the period 2011-2015.the paper also emphasizes the growing role of BPNN application based prediction models for banking sector with a case study of ICICI bank. We conclude that integrating BNPP models can be used as a communication tool between credit risk analyst and policy makers and serve in credit risk policy decision context.

Introduction

The recent global economy crashes are lessons learnt from the absence of effective early warning systems. The need of an effective failure prediction model to act as an alarm for the corporate is the basic need of any economic system. The model has to be robust over time so that it can sustain the variations in the terms of credit being both the policy measures and the diluting norms of credit. This study analyses the ratios and uses tailored neural network model. The prediction of the financial ratios would convey the position of the firm to regulate the credit risk associated to bankruptcy.

Credit risk is an investor's risk of loss arising from a borrower who does not make payments as promised. Such an event is called a default. Another term for credit risk is default risk. Investor losses include lost principal and interest, decreased cash flow, and increased collection costs, which arise in a number of circumstances:

Credit analysis is a key component of modern finance. It is used in both the capital markets, evaluating bond investments and the banking markets, evaluating credit applications. Throughout the years many techniques have been developed to assess credit risks. These include credit scoring models often built around the 5Cs of credit (character, capacity, collateral, conditions and capital) and quantitative models pioneered by Beaver and Altman that focus on a borrower's probability of default (or inability to meet credit obligations).Finance, accounting and banking programs across the globe typically include a significant amount of credit risk assessment, usually in conjunction with the evaluation of financial statements. Likewise, there has been a continual development and refinement of credit and default assessment models in both the academic and practitioner worlds.Based on the evidences and circumstantial evaluation of financial institutes it is rational enough to conclude that the institutes from times immemorial have been engaged in risk modeling since the time they have been incorporated. From centuries the financial institutes like banks have operated on intuitive models that are based on personal judgment and experience.

Experience with the recent crisis forced the bank authorities and the central banks on the global level to draw a number of lessons. The result being the new Basel Capital Accord which enlisted guidelines that all banks should develop systematic validated methods for assessing the risks associated with lending. As a result the new rules may increase the operational security of the banks in granting the credit. They are required to establish objective criteria and techniques for modeling the assessment of risk cutting down dependence on subjective personal judgment. Basel II norms are adopted to prevent banks from unexpected losses, improved profitability, increase risk carrying capacity and undertake more obligations. In consistence with the Basel Accord, it is realistic to expect that additional analytical tools be designed to manage the credit risk more effectively in the periods to come. We can therefore hope that credit scoring models would serve as a platform for these changes. Even though statistical models were formulated about 30 years ago, credit lending does not have any bench marks still paucity of default information continues to prove a principal obstacle to researchers.

The paper studies the application of neural network in forecasting financial ratios. The financial ratios have been

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divided into pillars. The paper is an attempt to forecast the ratios so as to communicate the financial position of the firm by forecasting the financial ratios upto 2015. Thus the aspects of lending can be evaluated and reestablished. Within the framework of the present study, it was attempted to construct a ratio model, which enable early identification of pattern for bankruptcy. The ratios are divided into pillars to state the area of financial viability. Neural network has been used for the forecasting of financial ratios. The financial position of the banks when the go out to obtain credit can be computed. The forecasted position can also benefit in planning the repayment period and also assists to plan the terms of credit.

Literature Review

Credit risk is probability that a borrower will fail to make required payments of principle and interest over the life of the loan. Risk plays an important role in the lending arena. At loan inception, the lender estimates the expected credit risk that the borrower presents over the life of the loan. Absent provisions to control the increase in credit risk, the lender prices the expected outcome in the interest rate of the loan. Both lender and borrower suffer when the expected credit risk of borrower is high, the lender with increased risk over the life of the loan and the borrower with a high interest rate. These suggest that both the parties involved in credit lending benefit when provisions are included in contrast to control increase in credit risk. Bankruptcy is the condition in which a business cannot meet its debt obligations petitions a federal district court for either.This paper examines an alternative approach using neural network to forecast financial ratios so as to relate to prediction of bankruptcy before it actually occurs.

Academic studies seeking to predict corporate bankruptcies have a long history. An early study was based on a univariate analysis approach (Beaver 1966). Multivariate analysis techniques used in subsequent studies include discriminant analysis (Altman 1968), logit and probit regressions (Ohlson 1980, Zmijewski 1984) and hazard analysis (Shumway 2001). The exact variables used in these studies vary and include both accounting-based and market-based variables, but all of these studies have proposed reduced form models which are able to predict corporate bankruptcies with a fair degree of accuracy. Shumway (2001) compares the forecasting accuracy of a hazard model using a set of five variables, comprising two accounting-based and three market-based variables, to Altman's (1968) and Zmijewski's (1984) specifications which used mainly accounting-based variables, and concludes that the hazard model with accounting and market-based variables is the most accurate. In an examination of secular changes in the ability of accounting variables to predict bankruptcy, Beaver et al. (2005) find a slight decline in the predictive ability of financial ratios based on accounting variables over the period 1962 to 2002, with a corresponding improvement in the incremental predictive ability of market-based variables.

Structural models of default, based on Merton (1974) and commercialized by firms like Moody's KMV (Crosbie and Bohn 2001), have also been studied (e.g., Vassalou and Xing 2004; Hillegeist et al. 2004). Although Hillegeist et al. (2004) find that these structural models outperform purely accounting-based, reduced form models, Campbell et al. (2008) find that information from structural models does not add any additional explanatory power to reduced form models utilizing both accounting and market information. Bharath and Shumway (2008) show that the functional form suggested by the Merton model is useful for predicting defaults, though it does not serve as a sufficient statistic for the probability of default.

Model Design and Methodology

In this paper, a two-step methodology has been adopted. The part A provides the steps formulated for the prediction of financial ratio pillars, followed by part B which enlists the steps followed for the prediction of financial ratios using artificial neural networks.

Part A: Formulation of Ratio Pillars

The basic ratios are formulated from details mentioned in published statements like balance sheet, cash flow statements, yearly details of banks, profit and loss statements obtained from CMIE database, Reserve Bank of India. Data is also taken from the official websites of the banks, financial institutions and the internet. Prior studies have identified financial ratio for bankruptcy prediction and the usefulness of these financial ratios for bankruptcy prediction can be known from the literature survey. Consequently this research work uses financial data i.e. published time series data for the last 11 years from 2000 to 2009. This research tries to present a holistic view by incorporating all various ratios and then relating them to examine the explanatory capabilities of the financial ratios to suggest the position of the bank. Construction of the basic ratios into ratio pillars is a vital ingredient of the basic work done prior to deployment of neural network.

Part A: Eight ratio pillars have been constructed for the needful being

1. Investment Valuation Ratio Pillar.
2. Profitability Ratio Pillar.
3. Management Efficiency Ratio Pillar.
4. Profit & Loss Ratio Pillar.
5. Debt Coverage Ratio Pillar.
6. Cash Flow Indicator Ratio Pillar.
7. Leverage Ratio. Ratio Pillar.
8. Overall Performance Ratio Pillar.

Part B: Prediction of Financial Ratios using ANN Model

1. Catering to Neural Network inputs
2. Tolerance level Minimization
3. Data convergence using Neural Networks

4. Formulation of Absolute error
5. Prediction of ratios in each Ratios pillar
6. Data Validation

BPNN Model application for ICICI Bank.

ICICI Bank is India's second-largest bank with total assets of 3,997.95 billion (US$ 100 billion) at March 31, 2008 and profit after tax of Rs. 41.58 billion for the year ended March 31, 2008. ICICI Bank is the most valuable bank in India in terms of market capitalization and is ranked second amongst all the companies listed on the Indian stock exchanges. In terms of free float market capitalization. The Bank has a network of about 1308 branches and 3,950 ATMs in India and presence in 18 countries. ICICI Bank offers a wide range of banking products and financial services to corporate and retail customer through a variety of delivery channels and through its specialized subsidiaries and affiliates in the areas of investment banking, life and non-life insurance, venture capital and asset management. This is among the highest levels of capital adequacy in large Indian banks, which reflects the healthy capital position and comfortable level of leverage. Its banking and non-banking subsidiaries are also well-capitalised.

The basic input sheets for all the eight pillars are formulated for ICICI Bank. The process of ratio pillar formulation uses the book formulae for computation of the ratios in each pillar, which will further be used as input parameters for Artificial Neural Network. The details of the ratios and the values are enlisted in the Table 1.

Table1: Ratios used as Inputs for the Neural Network for ICICI bank.

Ratio Pillars	**Ratios Specifications**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Investment Valuation	Div /earnings ratio	4.1	4.9	5.7	6.5	7.3	8.1	8.5	10	11
	Operating Profit Per Share (Rs)	19.7	22.9	26.2	29.4	32.7	35.9	36.7	42.1	51.2
		3	79	28	77	26	75	5	9	9
	Net Operating Profit Per Share (Rs)	123.46	145.65	167.84	190.03	212.22	234.40	196.87	316.45	354.71
	Free Reserves Per Share (Rs)	1.7466	1.8544	2.0388	49.93	97.82	145.7	193.2	199.5	346.2
	Earnings Per Share	22.65	24.08	25.51	26.93	28.36	29.79	28.55	34.59	37.37
	Book Value	5.0	6.9	8.2	68.	128	188	249	270	417
	Net Operating Income per share	1.2021441	2.4636899	3.1087187	0.3940493	0.2207377	0.1579234	0.1144063	0.1279435	0.0897847
Profitability	Interest Spread	0.09	0.01	0.06	0.68	1.30	1.92	2.67	3.43	3.51
	Adjusted Cash Margin (%)	20.28	19.41	18.55	17.68	16.81	15.95	17.55	12.3	11.81
	Net Profit Margin	15.44	14.99	14.45	13.95	13.45	12.96	14.12	10.81	10.51
	Return on Long Term Fund (%)	99.52	94.64	89.76	84.88	80.00	75.13	56.24	82.46	62.34
	Return on Net Worth (%)	25.29	23.43	21.56	19.69	17.83	15.93	14.33	13.17	8.94
	Adjusted Return	1	1	1	1	1	1	1	1	8

	on Net Worth (%)	9.5	8.2	7.0	5.7	4.5	3.2	1.4	2.3	.8
	Gross Profit Ratio	85.6	85.91	93.12	99.05	96.68	88.72	87.07	92.69	89.58
Profit & Loss	Interest Expended / Interest Earned	72.04	72.00	71.96	71.91	71.88	71.83	69.62	71.14	76.28
	Other Income / Total Income	3.96	3.67	3.25	2.89	2.54	2.18	2.59	1.07	0.17
	Operating Expense / Total Income	24.2	24.58	24.96	25.33	25.70	26.08	25.86	28.87	26
	Selling Distribution Cost Composition	13.594	12.34	11.086	9.832	8.578	7.324	4.8	6.12	4.43
	Current Ratio	0.01	0.00	0.01	0.03	0.04	0.06	0.08	0.09	0.11
	Quick Ratio	4.86	3.26	1.66	0.06	1.54	3.14	6.64	6.04	6.42
Leverage	Financial Leverage	4.69	6.379	11.188	4.6888	3.6	4.099	5.4884	5.6451	5.4411
	Net financial leverage	16.9	18.835	18.384	17.754	16.413	16.045	14.856	15.184	12.015
	Operating Leverage	0.00008	0.00046	0.00011	0.00011	0.00011	0.00007	0.0004	0.0003	0.0003

	Interest Coverage	1.16	1.2008	1.2544	1.2366	1.3388	1.337	1.3778	1.4445	1.4444
	Long Term Debt / Equity	3911.6	4811.76	5311.7966	5800.3299	6300.9144	7333.8633	7800.3299	9022.9544	9322.9552
	Debt-Equity ratio	4966.887	5999.7422	6611.6544	7144.1887	7744.8722	8733.8044	9338.38	10076.50	11142.61
	Owner's fund as % of Total Source	23.0	25.5788	28.9927	32.6887	38.4411	45.7382	52.5225	59.4699	77.6448
	Total debt to assets ratio	1	1	1	1	1	1	1	1	1
	Long term debt to assets ratio	0.78	0.8003	0.8004	0.8113	0.8114	0.84	0.8332	0.8339	0.8117
Debt Coverage	Credit Deposit Ratio	77.5	78.82	80.07	81.32	82.54	83.85	87.59	83.83	84.99
	Investment Deposit Ratio	30.2	32.17	34.13	36.06	38.08	40.02	46.07	41.15	42.68
	Cash Deposit Ratio	-1.69	-0.38	0.9188	2.2233	3.5288	4.8333	5.777	6.99	10.12
	Total Debt to Owners Fund	15.8	14.62	13.40	12.19	10.97	9.7588	7.445	9.5	5.27
	Financial Charges Coverage Ratio	1.	1.	1.	1.	1.	1.	1.	1.	1.

		39	37	36	34	34	33	39	25	25	
	Financial Charges Coverage Ratio Post Tax	1.37	1.35	1.33	1.32	1.36	1.29	1.33	1.22	1.2	
Cash Flow	Dividend Payout Ratio Net Profit	27.6	28.58	29.48	30.41	31.33	32.24	34.08	33.89	33.12	
	Dividend Payout Ratio Cash Profit	20.0	21.25	22.46	23.62	24.82	26.09	27.36	28.84	29.08	
	Earning Retention Ratio	72.6	71.60	70.56	69.52	68.44	67.44	65.82	64.8	66.35	
	Cash Earning Retention Ratio	80.2	78.95	77.64	76.33	75.02	73.70	72.58	70.22	70.51	
	Adjusted Cash Flow Times	77.3	74.30	71.23	68.17	65.08	62.01	52.3	65.12	52.34	
Managerial Efficiency	Interest Income / Total Funds	8.4778	8.5977	8.7116	8.8355	8.9554	9.0736	8.36	9.555	10.6	
	Interest Expended / Total Funds	4.866	4.992	4.999	5.006	5.012	5.019	4.58	5.49	6.31	
	Operating Expense / Total Funds	2.15	2.20	2.26	2.31	2.32	2.42	2.22	2.79	2.76	
	Profit Before Provisions / Total Funds	1.399	1.399	1.38	1.38	1.37	1.37	1.49	1.19	1.4	
	Net Profit / Total Funds	1.35	1.32	1.28	1.25	1.21	1.18	1.21	1.04	1.12	
	Loans Turnover	0.	0.	0.	0.	0.	0.	0.	0.	0.	

		13	13	14	14	15	15	15	17	2
	Total Income / Capital Employed (%)	8.81	8.97	8.99	9.08	9.17	9.26	8.58	9.65	10.6
	Interest Expended / Capital Employed (%)	4.86	4.92	4.99	5.06	5.12	5.19	4.58	5.49	6.31
	Asset Turnover Ratio	1.41	1.80	2.19	2.59	2.98	3.38	2.94	4.52	5.61
Overall	Capital Adequacy Ratio	9.12	9.615	10.10	10.60	11.09	11.58	11.88	12.34	13.47
	Advances / Loans Funds (%)	59.0	61.02	62.95	64.88	66.81	68.74	65.66	76.16	78.31
	Return on invested capital (ROIC)	0.90622	0.62367	0.41331	0.09469	0.08999	0.09266	0.06833	0.03744	0.02667
	Return on Equity (ROE)	0.02	0.01333	0.01992	0.07922	0.09552	0.09911	0.10555	0.11255	0.13288
	Fixed Assets Ratio	1.36	1.59229	1.85512	2.06196	2.39966	3.64244	3.38588	3.59857	3.87166
	Capital Turnover Ratio	0.0109	0.00757	0.00811	0.03177	0.02279	0.02667	0.03499	0.05255	0.06088
	Sales /net fixed Assets	2.63	2.33302	2.38009	2.49581	3.41041	3.71063	3.02663	2.14447	2.18555

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BPNN Modeling analysis, results and outcomes

After the computation of the basic ratio pillars, as suggested by Table 1, this section uses the ratios in each pillar as inputs to train the network. The network after training computes the values of the ratios from 2009 upto the year 2015 at different tolerance level. The validation is done by the values obtained for the year 2009 and 2010.The tolerance level that provides the closest values is considered for prediction. The Table 2 provides details of the convergence study done for all the pillars for the banking the study. Table 3 provides details of the percentage error at the adopted level of tolerance.

Table 2: The convergence detail for ICICI Bank.

Ratio Pillar	Size	Tolerance Level	Epochs
Investment Valuation Ratio	1-8-7	0.1	2009693
Profit & Loss Ratio	1-7-6	0.1	2020624
Profitability Ratio	1-8-7	1	5788184
Leverage Ratio	1-10-9	1	7399332
Debt Coverage Ratio	1-7-6	0.1	1362687
Cash Flow Ratio	1-6-5	0.1	1445500
Managerial Efficiency Ratio	1-10-9	0.1	2345678
Overall Ratio	1-8-7	2	3557337

Table 3: The percentage error and Tolerance Level for the Ratio Pillars

Ratio Pillar	Tolerance	Ratios	2009			2010		
			Actual	*Predicted*	*%Error*	*Actual*	*Predicted*	*%Error*
Investment Valuation	0.1	Dividend Per Share	11	11.352	-3.1	12	11.679	23.388
		Operating Profit Per Share (Rs)	48.58	49.504	-1.903	49.8	50.527	0.254
		Net Operating Profit Per Share (Rs)	343.59	345.3	-0.498	293.74	300.493	-7.244
		Free Reserves Per Share	351.0	332.441	5.298	356.9	347.375	6.281
		(Rs)	4			4		
		Earnings Per Share	33.76	35.435	-4.9	36.1	35.809	-1.48
		Book Value	4449.94	421.435	5.283	463.0	444.547	4.182
		Net Operating Income per share	0.076	0	99.933	0.078	0	111575.6
Profit & Loss	0.1	Interest Expended / Interest Earned	73.09	0.86	26.22	1.74	0.13	5.94
		Other Income / Total Income	72.555	3.962	26.155	13.051	0.082	6.784
		Operating Expense / Total Income	0.774	-2164.71	4.649	-978.7	42.664	28.565
		Selling Distribution Cost Composition	73.122	0.175	27.431	1.21	0.143	9.496
		Current Ratio	72.81	3.962	26.28	13.48	0.097	8.684
		Quick Ratio	0.655	1951.97	5.218	6176	38.78	-8.33
Profitability	0.1	Gross Profit Ratio	89.22	89.613	-0.4	91.14	90.374	0.84
		Adjusted Cash Margin (%)	14.76	13.519	8.406	13.13	13.206	-0.577
		Net Profit Margin	13.31	11.807	11.292	12.081	11.68	3.316
		Return on Long Term Fund (%)	97.35	59.804	38.568	100.337	32.836	67.274
		Return on Net Worth (%)	17.77	5.916	66.71	15.091	2.051	86.409
		Adjusted Return on Net Worth (%)	17.85	9.095	49.049	17.535	4.003	77.172
		Gross Profit Ratio	90.092	86.593	3.883	84.595	83.82	0.916
Leverage	0.1	Interest Income / Total Funds	4.291	6.312	-47.08	4.383	7.257	-65.557
		Interest Expended / Total Funds	13.733	14.12	-2.82	12.622	13.084	-3.665
		Operating Expense / Total Funds	0	0.001	-1616	0	0.001	551.908
		Profit Before Provisions /	1.325	1.029	22.27	1.466	0.867	40.875

		Total Funds			5				*Managerial Efficiency*	0.1	Interest Income / Total Funds	9.82	10.405	-5.955	8.82	10.536	-19.454
		Net Profit / Total Funds	1253.44	546.606	56.392	1171.11	682.732	41.703			Interest Expended / Total Funds	5.83	6.177	-5.957	4.74	6.271	-22.292
		Loans Turnover	1519.078	1446.361	4.787	1407.961	1395.769	0.866			Operating Expense / Total Funds	2.6	2.765	-6.359	2.59	2.784	-7.471
		Total Income / Capital Employed (%)	91.273	25.699	71.844	87.462	25.08	71.325			Profit Before Provisions / Total Funds	1.3	1.326	-2	1.41	1.304	7.505
		Interest Expended / Capital Employed (%)	1	0.999	0.057	1	0.999	0.055			Net Profit / Total Funds	0.96	1.092	-13.	1.08	1.099	-1.73
		Asset Turnover Ratio	0.825	0.837	-1.429	0.84	0.839	0.169			Loans Turnover	0.18	0.159	11.68	0.17	0.159	6.473
Debt Coverage	0.1	Credit Deposit Ratio	91.44	82.455	9.826	90.04	82.455	8.377			Total Income / Capital Employed (%)	9.9	10.425	-5.303	8.9	10.552	-18.566
		Investment Deposit Ratio	46.35	43.128	6.951	53.28	43.128	17.685			Interest Expended / Capital Employed (%)	5.83	6.177	-5.958	4.74	6.271	-22.292
		Cash Deposit Ratio	10.14	8.218	18.952	10.72	8.218	18.475			Asset Turnover Ratio	5.14	5.504	-7.087	4.6	5.589	-21.5
		Total Debt to Owners Fund	4.42	6.231	-40.97	3.91	6.231	-39.358	**Overall**	0.1	Capital Adequacy Ratio	14.25	13.826	2.976	14.40	13.937	3.221
		Financial Charges Coverage Ratio	1.25	1.326	-6.116	1.33	1.326	0.412			Advances / Loans Funds (%)	78.34	77.469	1.112	80.60	77.772	3.513
		Financial Charges Coverage Ratio Post Tax	1.2	1.288	-7.303	1.26	1.288	-1.998			Return on invested capital (ROIC)	0.031	0.028	8.719	0.041	0.027	35.188
Cash-flow	0.1	Dividend Payout Ratio Net Profit	36.6	35.594	2.749	37.31	36.676	1.7			Return on Equity (ROE)	0.077	0.089	-16.25	0.069	0.079	-13.981
		Dividend Payout Ratio Cash Profit	31	30.674	1.052	32.33	31.842	1.51			Fixed Assets Ratio	4.271	3.99	6.578	4.7	4.383	6.737
		Earning Retention Ratio	63.23	64.586	-2.145	61.4	62.589	-1.936			Capital Turnover Ratio	0.049	0.053	-8.594	0.052	0.054	-4.554
		Cash Earning Retention Ratio	68.87	67.979	1.293	66.7	67.975	-1.912			Sales /net fixed Assets	1.573	1.586	-0.8	1.346	1.46	-8.47
		Adjusted Cash Flow Times	49.41	50.871	-2.956	44.79	46.631	-4.111									

Observations:

The ANN has been trained for prediction of ratios in each ratio pillar. This section provides a discussion of findings over the predicted ratios .It suggests the ratios that

would viably be predicted in this model terming them as included ratios. It also provides the details of the ratios that cannot be predicted and would be excluded from the study. The section provides details of the predicted ratios of each pillar for all the pillars for the banks in the study. Certain suggestions and recommendations are also provided based on the analysis. The ratio pillars have further been described in detail:

The validation was carried out for all the ratios. By the analysis of standard error the included ratios and excluded ratios were formulated. The ratios that have shown a deviation greater than 25% from the actual field data estimates are ignored. Such ratios are termed as excluded ratios. The excluded ratios have not been considered in the prediction process and have been dropped out from the prediction process. The ratios are enlisted in *Table 4.*The estimates from 2001 to 2008 were applied to train the backpropagation neural network and subsequently estimate the values for the year 2009 to 2010 the data values were used for validation. Based on these values predictions were drawn using BPNN from 2011 to 2015. The market has witnessed several ups and downs during the period 2005 and 2010 and the modelled BPNN has been able to closely predict the values from 2005 to 2010. The trained BPNN has been able to forecast the values of the internal included ratios of the ratio pillar in approximation to the actual values suggesting that the BPNN has the ability to forecast the financial ratios.

Table 4: Included and Excluded ratios for ICICI Banks.

Ratio Pillars	SE	Total	Included Ratios	Excluded Ratios
IVR	0.1	7	6- Dividend Per Share, Operating Profit Per Share (Rs), Net Operating Profit Per Share (Rs), Free Reserves Per Share (Rs), Earnings Per Share, Book Value	1- Net Operating Income per share
Profitability	0.1	7	7: Interest Spread, Adjusted Cash Margin(%), Net Profit Margin, Return on Long Term Fund(%), Return on Net Worth(%), Adjusted Return on Net Worth(%), Gross profit Ratio	Nil
P&L	0.1	6	3-Interest Expended / Interest Earned, Operating Expense / Total Income, Quick Ratio	3-Other Income / Total Income, , Selling Distribution Cost Composition, Current Ratio
Leverage	0.1	9	4:Net financial leverage, Debt-Equity ratio, Total debt to assets ratio, Long term debt to assets ratio	5:Financial Leverage, Operating Leverage, Interest Coverage, Long Term Debt / Equity, Owner's fund as % of Total Source
Debt Coverage	0.1	6	2- Investment Deposit Ratio, Cash Deposit Ratio.	4- Credit Deposit Ratio, Total Debt to Owners Fund, Financial Charges Coverage Ratio, Financial Charges Coverage Ratio Post Tax
M E	0.1	5	5:Dividend Payout Ratio Net Profit, Dividend Payout Ratio Cash Profit, Earning Retention Ratio, Cash Earning Retention Ratio, Adjusted Cash Flow Times	Nil
Overall	1	9	9:Interest Income / Total Funds, Interest Expended / Total Funds, Operating Expense / Total Funds, Profit Before Provisions / Total Funds, Net Profit / Total Funds, Loans Turnover, Total Income / Capital Employed(%), Interest Expended / Capital Employed(%), Asset	Nil

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			Turnover Ratio	

Analysis & Findings

As per the above convergence study the table 5 provided the details of the size of ANN used for prediction and the associated level of tolerance.

Table 5: Details in brief of the predicted ratios in all eight pillars:

Ratio Pillar	Size	Tolerance Level	Epochs
Investment Valuation Ratio	1-8-7	0.1	8629110
Profit & Loss Ratio	1-7-6	0.1	2205347
Profitability Ratio	1-8-7	0.1	3316919
Leverage Ratio	1-10-9	0.1	1362687
Debt Coverage Ratio	1-7-6	0.1	3362689
Cash Flow Ratio	1-6-5	0.1	5364532
Managerial Efficiency Ratio	1-10-9	0.1	9995099
Overall Ratio	1-8-7	0.1	1209775

Ratio Pillar	Tolerance	Ratios	2009	2010	2011	2012	2013	2014	2015
Investment Valuation	0.1	*Dividend Per Share*	9.89	10.76	11.35	11.68	11.84	11.91	11.94
		Operating Profit Per Share (Rs)	43.73	52.33	49.50	50.53	50.95	51.12	51.19
		Net Operating Profit Per Share (Rs)	297.08	328.96	345.30	300.49	295.53	294.20	280.44
		Free Reserves Per Share (Rs)	219.18	329.83	332.44	347.37	353.07	355.18	356.01
		Earnings Per Share	33.27	36.64	35.43	35.81	35.97	36.03	36.06
		Book Value	285.31	399.34	421.44	444.55	454.65	458.84	460.64
Profit & Loss	0.1	*Interest Expended / Interest Earned*	72.56	72.81	72.99	73.08	73.11	73.12	73.12
		Operating Expense / Total Income	26.16	26.28	26.40	26.52	26.62	26.71	26.78
		Quick Ratio	6.78	8.68	8.41	8.91	9.20	9.34	9.41
Profitability	0.1	*Interest Spread*	3.97	5.31	5.58	5.77	5.92	6.03	5.12
		Adjusted Cash Margin (%)	12.25	13.37	13.56	9.84	9.21	8.67	8.20
		Net Profit Margin	10.21	11.77	10.35	9.97	9.62	9.31	9.03
		Return on Long Term Fund (%)	61.15	47.41	54.00	50.94	46.23	45.87	43.82
		Return on Net Worth (%)	8.59	7.22	6.12	5.24	4.55	4.01	3.58
		Adjusted Return on Net Worth (%)	8.06	7.53	6.66	5.94	5.34	4.84	4.44
		Gross profit Ratio	89.61	90.37	90.15	88.95	88.76	91.59	88.44
Leverage	0.1	*Net financial leverage*	14.12	13.08	13.44	15.90	15.23	15.47	16.63
		Debt-Equity ratio	1446.36	1395.77	1269.13	1308.22	1335.95	1355.30	1368.74
		Total debt to assets ratio	1.00	1.00	1.00	1.00	0.99	1.00	1.00
		Long term debt to assets ratio	0.84	0.84	0.82	0.79	0.81	0.81	0.82
Debt Coverage	0.1	*Investment Deposit Ratio*	43.13	43.86	44.49	45.03	45.50	45.90	46.25

		Cash Deposit Ratio	8.22	8.74	9.14	9.44	9.67	9.85	9.98
Cash-flow	0.1	*Dividend Payout Ratio Net Profit*	35.59	36.68	39.76	38.83	39.91	39.98	34.06
		Dividend Payout Ratio Cash Profit	30.67	31.84	33.00	36.16	36.32	36.46	36.61
		Earning Retention Ratio	64.59	62.59	62.59	63.59	62.60	62.60	60.60
		Cash Earning Retention Ratio	67.98	67.98	65.97	66.97	74.96	74.96	74.95
		Adjusted Cash Flow Times	50.87	46.63	48.39	45.15	42.91	50.67	48.43
Managerial Efficiency	0.1	*Interest Income / Total Funds*	10.40	10.54	10.58	10.59	10.59	10.59	10.60
		Interest Expended / Total Funds	6.18	4.27	4.30	5.30	5.31	6.31	6.31
		Operating Expense / Total Funds	2.77	2.78	2.79	2.79	2.79	2.79	2.79
		Profit Before Provisions / Total Funds	1.33	1.30	1.28	1.27	1.25	1.24	1.23
		Net Profit / Total Funds	1.09	1.10	1.10	1.09	1.06	1.04	1.00
		Loans Turnover	0.16	0.16	0.16	0.16	0.16	0.16	0.16
		Total Income / Capital Employed (%)	10.43	10.55	10.59	10.61	10.61	10.61	10.61
		Interest Expended / Capital Employed	6.18	6.27	6.30	6.30	6.31	6.31	6.31
		(%)							
Overall	0.1	*Capital Adequacy Ratio*	13.83	13.94	13.86	13.44	13.51	13.59	13.68
		Advances / Loans Funds (%)	77.47	77.77	77.95	78.11	78.30	78.54	78.82
		Return on invested capital (ROIC)	0.03	0.03	0.03	0.02	0.02	0.02	0.02
		Return on Equity (ROE)	0.09	0.08	0.08	0.09	0.10	0.08	0.08
		Fixed Assets Ratio	3.99	4.38	4.59	4.69	4.90	4.99	4.92
		Capital Turnover Ratio	0.05	0.05	0.06	0.06	0.06	0.06	0.06
		Sales /net fixed Assets	1.59	1.46	1.40	1.35	1.29	1.21	1.11
		Capital Adequacy Ratio	13.83	13.94	13.86	13.44	13.51	13.59	13.68

In the *Investment Valuation Ratio* In the study it has been observed that the Dividend per Share moves in the range from 4% to 19% and the similar swing of 0.2% to 9% has been predicted by the neural network. (Graph 1). The ratio Operating Profit Per Share (Rs) shows a movement of 2% to 21% as suggested by the network also being 0.1% to 19 %.(Graph 2). The ratio Net Operating Profit Per Share (Rs), shows a movement of 3% to 16% as suggested by the network also being 1% to 12 %.(Graph 3). The ratio Free Reserves Per Share (Rs) shows a movement of 1% to 48% a similar trend is projected by the network. (Graph 4). For Earnings Per Share shows a movement from 2% to 9% is observed and the network shows a similar fashion being approximately 0.1% to 10 %(Graph 5). For Book Value shows a movement from 4% to 54% is observed and the network shows a similar fashion being approximately 0.1% to 45 %(Graph 6)

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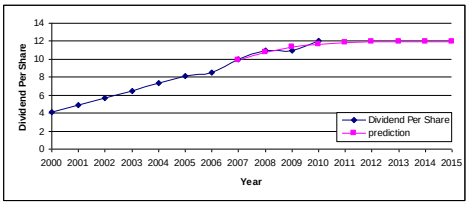
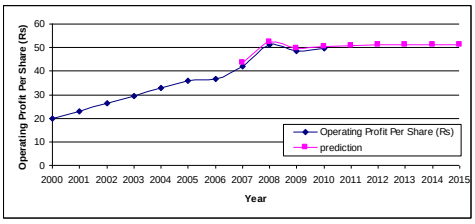
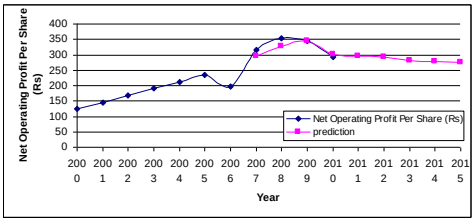


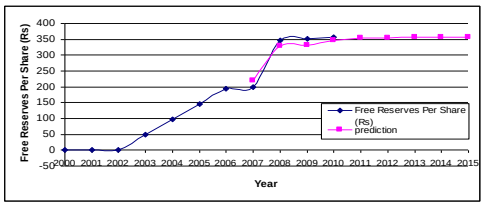
Graph 1: Dividend Per Share



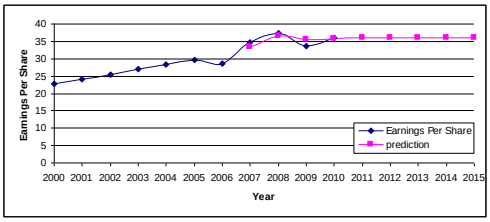
Graph 2: Operating Profit Per Share (Rs)



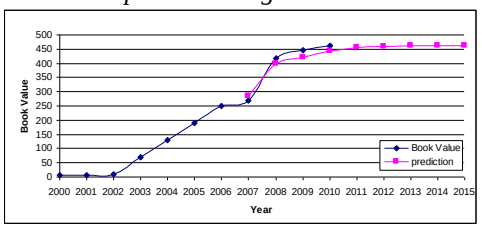
Graph 3: Net Operating Profit Per Share (Rs)



Graph 4: Free Reserves Per Share (Rs)

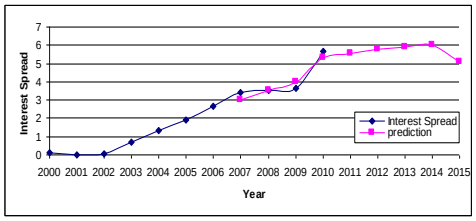


Graph 5: Earnings Per Share

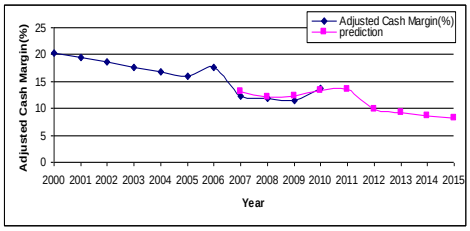


Graph 6: Book Value

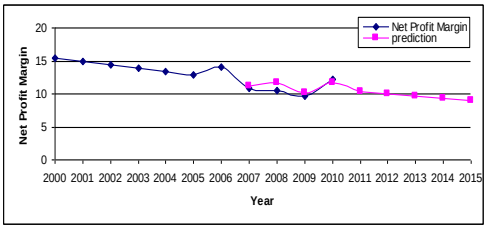
In the *Profitability Ratio Pillar* it has been observed that the Interest Spread ratio shows a range of 2% to 47%, similar kind of error in the range of 1% to 33% is predicted by the network (Graph 7). The Adjusted Cash Margin (%), moves in the range from 3% to 29% and the similar swing of 1% to 27% has been predicted by the neural network. (Graph 8) The ratio Net Profit Margin shows a movement of 2 % to 14% as suggested by the network also being 2% to 15 %.(Graph 9). The return on long term funds (%) shows a movement of 4 % to 24% as suggested by the network also being 0.7% to 22 %.(Graph 10). The ratio Return on Net Worth (%) moves in the range from 2% to 16% and the similar swing of 2% to 16% has been predicted by the neural network. (Graph 11).The ratio Adjusted Return on Net Worth (%),shows a movement of 7% to 20% as suggested by the network also being 6% to 16 %.(Graph 12). The ratio Gross Profit Ratio shows a movement of 0.3% to 5% a similar trend of 0.2% to 4% is projected by the network. (Graph 13)



Graph 7: Interest Spread



Graph 8: Adjusted Cash Margin (%)



Graph 9: Net Profit Margin

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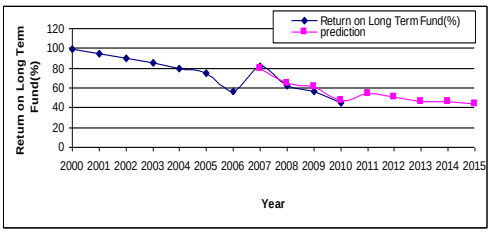
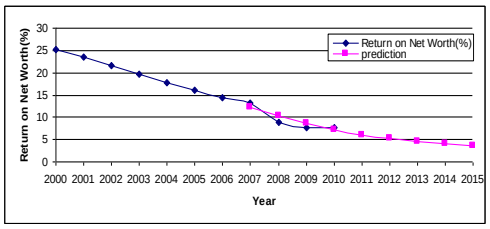
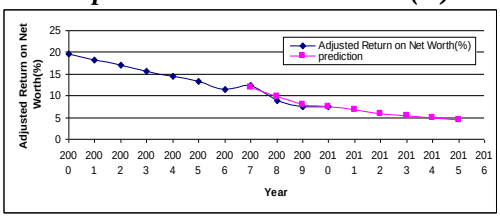


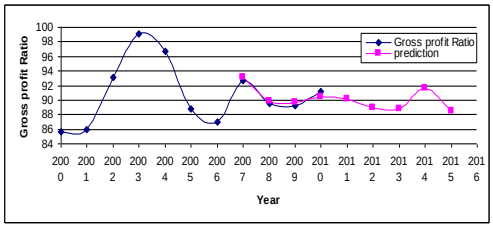
Graph 10: Return on Long Term Fund (%)



Graph 11: Return on Net Worth (%)

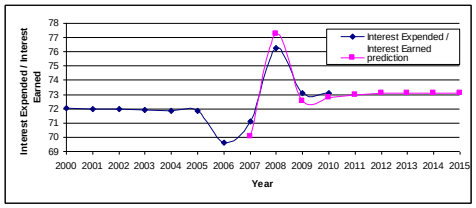


Graph 12: Adjusted Return on Net Worth (%)

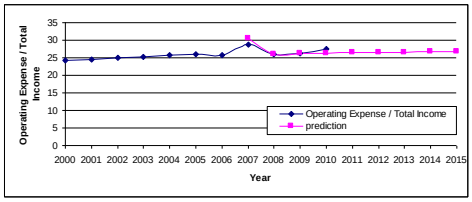


Graph 13: Gross profit Ratio

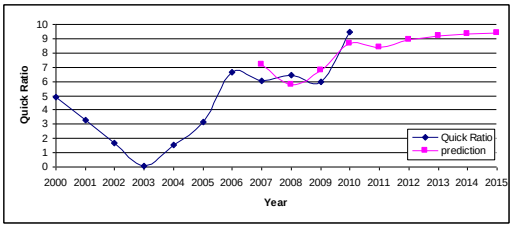
For the Profit and Loss Ratio it has been observed that the Interest Expended / Interest Earned moves in the range from 0.04% to 7% and the similar swing of 0.01% to 6% has been predicted by the neural network (Graph 14). The ratio Operating Expense / Total Income shows a movement of 0.8% to 11% as suggested by the network also being 0.2% to 14%(Graph 15).For Quick Ratio shows a movement from 6% to 59% is observed and the network shows a similar fashion being approximately 0.7% to 45 % (Graph 16)



Graph 14: Interest Expended / Interest Earned

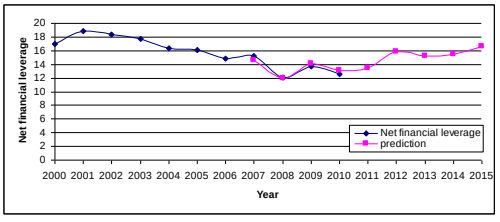


Graph 15: Operating Expense / Total Income

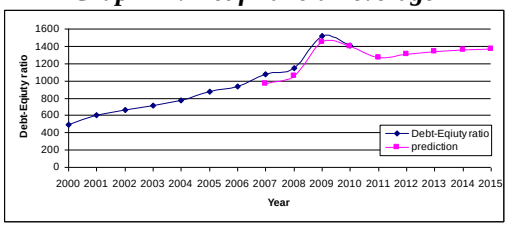


Graph 16: Quick Ratio

For the Leverage Ratio Pillar In the study it has been observed that the Net Financial Leverage moves in the range from 2% to 14% and the same movement of ratios has been predicted by the neural network being 1% to 18% (Graph 17). For the Debt-Equity ratio the ratios oscillate in the range from 7% to 32% and the network suggests a similar trend (Graph 18). For Total debt to assets ratio shows a movement from 0.001% to 1% is observed and the network moved a similar pattern (Graph 19). For the Long term debt to assets ratio shows a movement from 0.8% to 3% is observed and the network moved a similar pattern (Graph 20)



Graph 17: Net financial leverage



Graph 18: Debt-Equity ratio

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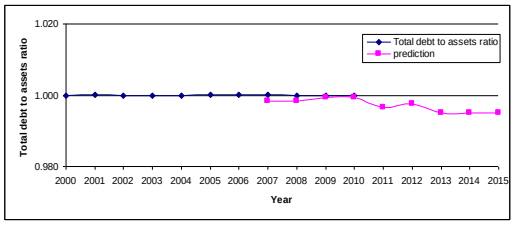
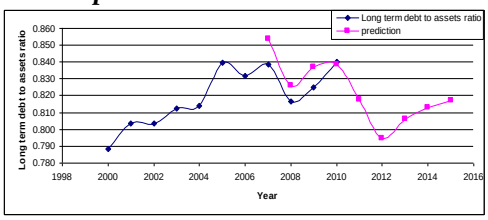
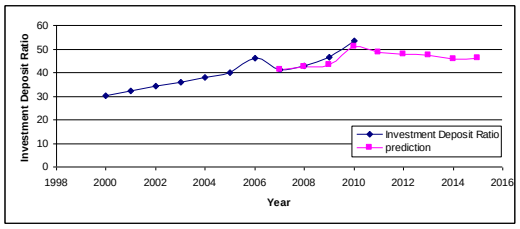


Graph 19: Total debt to assets ratio

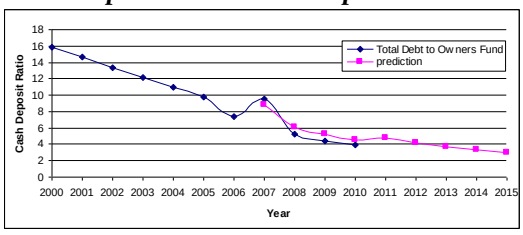


Graph 20: Long term debt to assets ratio

For the Prediction of Debt Coverage Ratio Pillar it has been observed that the Investment Deposit Ratio moves in the range from 3% to 14% and the similar swing of 3% to 17% has been predicted by the neural network (Graph 21). The ratio Cash Deposit Ratio shows a movement of 7% to 27% as suggested by the network also being 9% to 30 % (Graph 22)

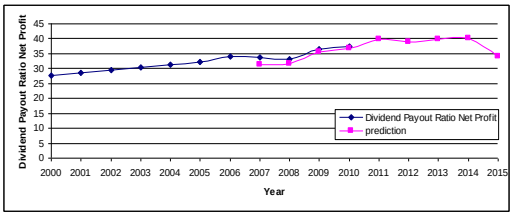


Graph 21: Investment Deposit Ratio

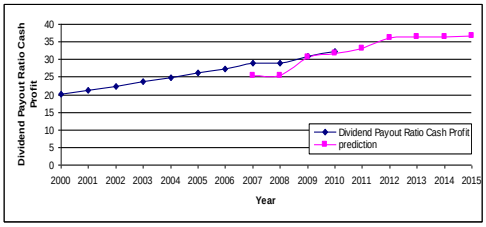


Graph 22: Total Debt to Owners Fund

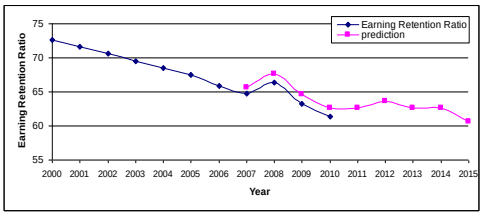
For the Prediction of Cashflow Ratio Pillar it has been observed that the Dividend Payout Ratio Net Profit show a range of 3% to 5%.a similar kind of error in the range of 3% to 8% is predicted by the network. (Graph 23) The Dividend Payout Ratio cash Profit moves in the range from 5% to 8% and the similar swing of 4% to7% has been predicted by the neural network (Graph 24). The ratio Earning Retention Ratio shows a movement of 14% to 4.73% as suggested by the network also being 1% to 2.5% (Graph 25). The ratio cash Earning Retention Ratio shows a movement of 1.6% to 3.1% a similar trend of 1.5% to 6% is projected by the network (Graph 26). For Adjusted Cash Flow Times shows a movement from 1.4% to 5% is observed and the network shows a similar fashion being approximately 1.8% to 5% (Graph 27).



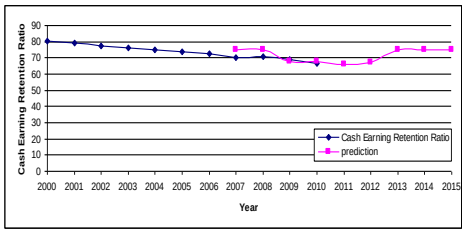
Graph 23: Dividend Payout Ratio Net Profit



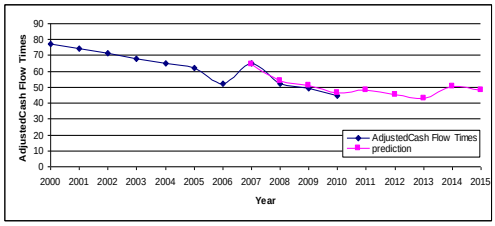
Graph 24: Dividend Payout Ratio Cash Profit



Graph 25: Earning Retention Ratio

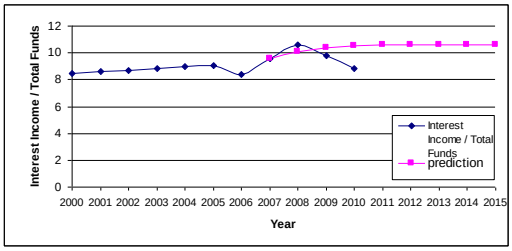


Graph 26: Cash Earning Retention Ratio

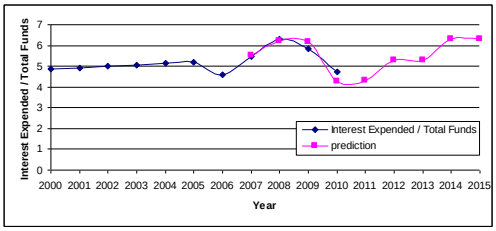


Graph 27: Adjusted Cash Flow Times

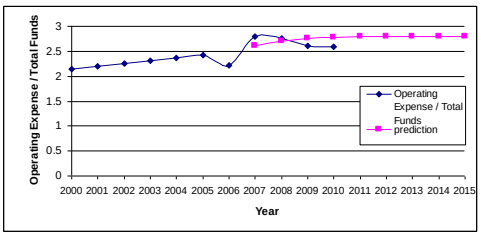
For the Prediction of Managerial Efficiency Ratio Pillar it has been observed that the Interest Income / Total Funds show a range of 1% to 7%, similar kind of error in the range of 0.1% to 5% is predicted by the network (Graph 28). The Interest Expended / Total Funds ratio moves in the range from 1.2% to 14% and the similar swing of 0.2% to 11% has been predicted by the neural network (Graph 29). The ratio Operating Expense / Total Funds shows a movement of 1% to 8% as suggested by the network also being 0.3% to 4 % (Graph 30). The ratio Profit before Provisions / Total Funds shows a movement of 0.3% to 9% a similar trend of 0.8% to 2% is projected by the network (Graph 31). For Net Profit / Total Funds, shows a movement from 2% to 7% are observed and the network shows a similar fashion being approximately 2% to 9% (Graph 32). The Loans turnover ratio being shows a movement from 3% to 17% is observed and the network shows a similar fashion being approximately 0.1% to 20% (Graph 33). The ratio being Total Income / Capital Employed (%) shows a movement from 1.2% to 19% is observed and the network shows a similar fashion being approximately 0.1% to 14 % (Graph 34). The Interest Expended / Capital Employed (%), shows a movement from 8% to 24% is observed and the network shows a similar fashion being approximately 0.2% to 21% (Graph 35). The Asset Turnover Ratio shows a movement from 5% to 15% is observed and the network shows a similar fashion being approximately 6% to 18% (Graph 36).



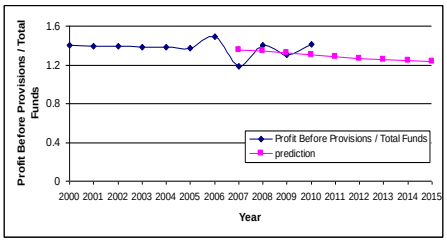
Graph 28: Interest Income / Total Funds



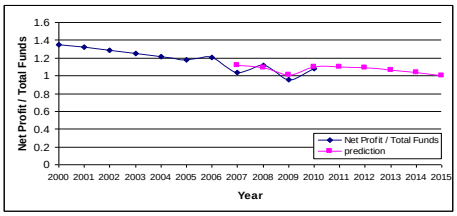
Graph 29: Interest Expended / Total Funds



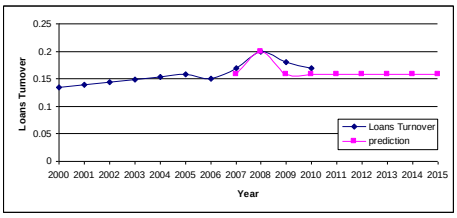
Graph 30: Operating Expense / Total Funds



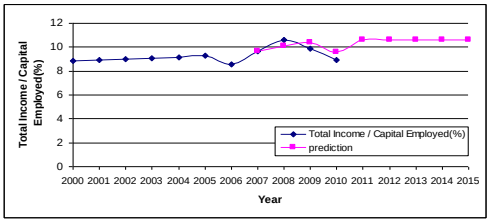
Graph 31: Profit before Provisions / Total Funds



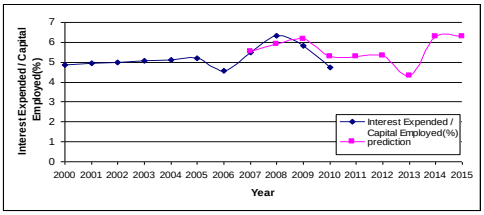
Graph 32: Net Profit / Total Funds



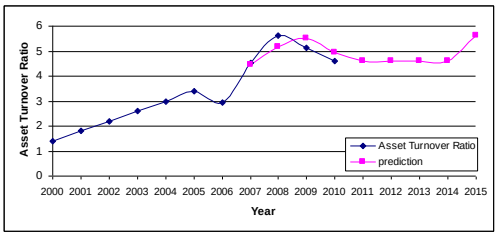
Graph 33: Loans Turnover



***Graph 34: Total Income / Capital Employed** (%)*

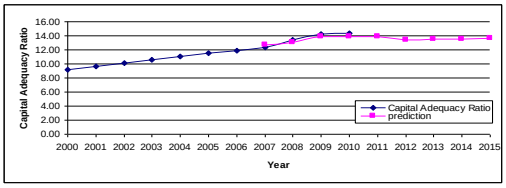


Graph 35: Interest Expended / Capital Employed(%)

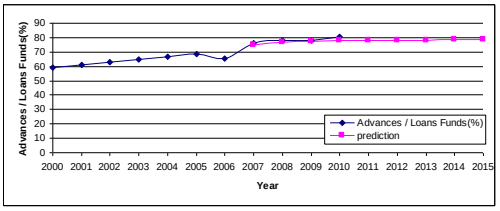


Graph 36: Asset Turnover Ratio

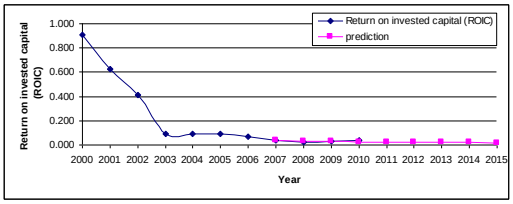
For the Prediction of Overall Ratio Pillar it has been observed that the Capital Adequacy Ratio moves in the range from 1% to 6% and the similar swing of 0.5% to 6% has been predicted by the neural network (Graph 37). The ratio Advances / Loans Funds (%) shows a movement of 2% to 6% as suggested by the network also being 0.2% to 4% (Graph 38). The ratio Return on invested capital (ROIC) shows a movement of 4% to 33% as suggested by the network also being 2% to 21% (Graph 39). The ratio Return on equity shows a movement of 4 % to 30% a similar trend is projected by the network (Graph 40). The ratio Fixed Assets Ratio shows a movement of 7% to 16% a similar trend is projected by the network (Graph 41). For Capital Turnover Ratio shows a movement from 5% to 15% is observed and the network shows a similar fashion being approximately 1% to 13 % (Graph 42). For Sales/Net Fixed Assets shows a movement from 1% to 36% is observed and the network shows a similar fashion being approximately 2% to 27% (Graph 43)



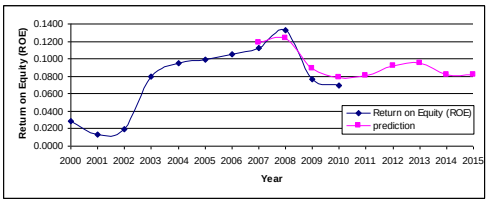
Graph 37: Capital Adequacy Ratio



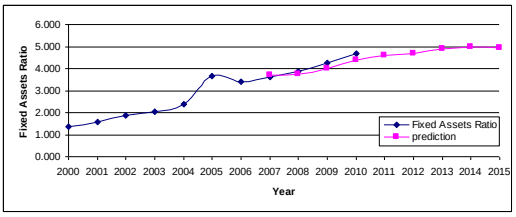
Graph 38: Advances / Loans Funds(%)



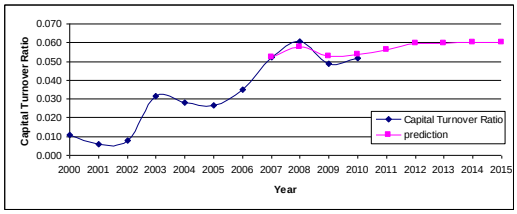
Graph 39: Return on invested capital (ROIC)



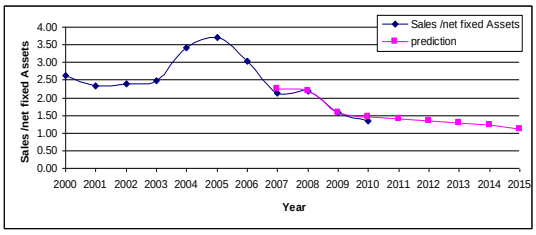
Graph 40: Return on Equity (ROE)



Graph 41: Fixed Assets Ratio



Graph 42: Capital Turnover Ratio



Graph 43: Sales /net fixed Assets

Profit before provisions and tax increased by 35.5% to Rs. 79.61 billion in fiscal 2008 from Rs. 58.74 billion in fiscal 2007 primarily due to an increase in net interest income by 29.6% to Rs. 73.04 billion in fiscal 2008 from Rs. 56.37 billion in fiscal 2007 and an increase in non-interest income by 27.2% to Rs.88.11 billion in fiscal 2008 from Rs. 69.28 billion in fiscal 2007, offset, in part, by an increase in non-interest expenses by 21.9% to Rs. 81.54 billion in fiscal 2008 from Rs. 66.91 billion in fiscal 2007. Provisions and contingencies (excluding provision for tax) increased by 30.5% during fiscal 2008 primarily due to a higher level of specific provisioning on non- performing loans, offset, in part by a reduction in general provision on loans. Profit before tax increased by 38.6% to Rs. 50.56 billion in fiscal 2008 from Rs. 36.48 billion in fiscal 2007. Profit after tax increased by 33.7% to Rs. 41.58 billion in fiscal 2008 from Rs. 31.10 billion in fiscal 2007. Net interest income increased by 29.6% to Rs. 73.04 billion in fiscal 2008 from Rs. 56.37 billion in fiscal 2007, reflecting an increase of 27.6% or Rs. 711.07 billion in the average volume of interest-earning assets and an increase in net interest margin to 2.22% in fiscal 2008 compared to 2.19% in fiscal 2007. Non-interest income increased by 27.2% to Rs. 88.11 billion in fiscal 2008 from Rs. 69.28 billion in fiscal 2007,primarily due to a 32.2% increase in fee income and a 14.0% increase in treasury and other non-interest incomes. Non-interest expenses increased by 21.9% to Rs. 81.54 billion in fiscal 2008 from Rs. 66.91 billion in fiscal 2007, primarily due to a 28.6% increase in employee expenses and a 31.6% increase in other administrative expenses. Provisions and contingencies (excluding provision for tax) increased to Rs. 29.05 billion in fiscal 2008 from Rs. 22.26 billion in fiscal 2007 primarily due to higher level of specific provisioning on retail loans due to change in the portfolio mix towards non-collateralised loans and seasoning of the loan portfolio, offset in part by a reduction in general provision on loans due to lower growth in the loan portfolio relative to fiscal 2007. Total assets increased by 16.0% to Rs. 3,997.95 billion at year-end fiscal 2008 from Rs. 3,446.58 billion at year-end fiscal 2007 primarily due to an increase in advances by 15.2% and an increase in investments by 22.1%. During the year, we made a follow-on public offering of equity shares in India and an issuance of American Depository Shares (ADSs) aggregating to Rs. 199.67 billion. Operating profit increased to Rs. 79.61 Billion for FY2008 from Rs. 58.74 Billion for FY2007 which is less than as compared to increased to Rs. 5,874 crore for FY2007 from Rs. 3,888 crore for FY2006 Profit before tax increased to Rs. 50.56 Billion for FY2008 from Rs. 36.48 Billion for FY2007 which is also less than as compared to increased to Rs. 3,648 crore for FY2007 from Rs. 3,097 crore for FY2006. Total interest income increased by 37.8% to Rs. 316.86 billion in fiscal 2008 from Rs.229.94 billion in fiscal 2007 and interest income, net of amortisation on Government securities, increased by 40.0% to Rs. 307.88 billion in fiscal 2008 from Rs. 219.95 billion in fiscal 2007 primarily due to an increase of 27.6% in the average interest earning assets and an increase of 83 basis points. Fee income increased by 32.2% to Rs. 66.27 billion in fiscal 2008 from Rs. 50.12 billion in fiscal 2007, primarily due to growth in fee income from structuring and advisory fees, fees from international operations, third party distribution fees. Total non-interest expense increased by 21.9% to Rs. 81.54 billion in fiscal 2008 from Rs. 66.91 billion in fiscal 2007, primarily due to a 28.6% increase in employee expenses and 31.6% increase in other administrative expenses. Interest income is increased at a higher rate than the previous year i.e. 47% in 2007 to61% in 2008.

The simulation study output suggests that if these parameters are incorporated in the policy decisions the viability of credit lending would in turn be enhanced as the chances of estimating the financial position of the firm at the time of lending and even at the time of changing the policy measures of credit be analysed.

Conclusion

In times of economic distress the BPNN model would provide assistance to finding the financial viability of the firm. The tailored back-propagation neural network endeavors to predict the financial ratios expressing the position of a firm to regulate the bankruptcy and assess the credit viability when a bank requires credit and can also be utilized to plan the periods of recovery of the lent amount. The analysis also suggests that the model can forecast the financial position of the firm in case of loan value enhancement as well as the extension of the repayment period implying to be effective in the designing of policy measures related to credit viability thus proves to be a vital tool to regulate the occurrence of credit defaults. As the ratio pillars incorporate all the terms to be included while assessment of the firm's financial position there are less chances of being misguided in the terms of credit lending hence the model can also act as an early warning system for the corporate and can be useful as a communication tool between the credit analyst and the management and hence serve in a practical credit risk policy context.

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