# Modeling NPA Time Series Data in Selected Public Sector Banks in India with Semi Parametric Approach

Gour Bandyopadhyay

**Abstract-** The research paper, entitled, 'Modeling NPA Time Series Data in Selected Public Sector Banks in India with Semi Parametric Approach' is devoted to an analytical study to reveal the movement of the financial parameter, GNPA over time. Diagnostic tool like Residuals vs Predictor Plot, Quantile Comparison Plots of the Residuals and and QQ Plot have been employed to examine appropriateness of Penalized Spline (Semi Parametric Curve Fit) model, to check the presence of outliers, and to detect departures from normality in the residual distribution for our data respectively. It is observed that Penalized Spline (Semi Parametric Curve Fit) model fits well with the given dataset. It is also observed that there exist very few outliers in some of the selected banks and residuals follow approximately normal distribution for the sample dataset. Penalized Spline (Semi Parametric Curve Fit) Model, establishes curve linearity in the given data. Goodness of fit statistics represented by R2, Sig of F statistics establishes high precision of the model and excellent fit for dataset in respect of the parameter GNPA. Finally, the Penalized Spline (Semi Parametric Curve Fit) model is extended to get the forecasted values for the respective data-set. Forecasted Values of GNPA for three years (2013, 2014 and 2015) of all the selected PSBs clearly demonstrates future upward trend in respect of the financial parameter GNPA for all the selected PSBs, which puts question mark on the wisdom and integrity of the top management in PSBs in India in handling credit portfolio. Such a situation undoubtedly deserves immediate and serious attention on the part of the regulators to relook into the practices of credit appraisal and monitoring of credit in PSBs in India.

**Index Terms—** Analysis of Trend of NPA, Forecasting Model, Gross Non Performing Assets, Non Performing Assets, Penalized Spline Technique, Public Sector Banks in India, Semi Parametric Approach, Time Series Data

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## 1 INTRODUCTION

IN a developing country like India, banking is seen as an instrument of development and has to essentially develop dynamism and capacity for adaptation for adjusting itself to the sweeping changes in the economy (Sharma, 1985) [1]. The evolution of Indian financial system, since the mid-eighties in general, and the launching of the economic policy in 1991, in particular, has been characterized by profound transformation as a result of prolonged and effective reform initiatives by Reserve Bank of India (RBI). The fundamental philosophy of the development process in India has shifted from closed and highly regulated regime to free market economy and the consequent liberalization, deregulation and globalization of the economy. One of the major challenges that the banking industry in India is facing today is the credit risks. Various dimensions of credit risks expose this fast growing industry to mounting Non Performing Assets (NPAs).

Though macro environmental factors including global recession, economic slowdown, rising inflation and inadequate legal frame work contributed heavily towards growth of distress asset in the banking sector, micro banking factors, including poor appraisal and follow-up, defect in the mindset of the

borrower and lender are no less important. Pressure from regulators towards strict adherence to international norms on asset quality has also contributed to rising bad loans figures in absolute terms in the Public Sector Banks (PSBs) in India in the last two decades.

The micro and macro impact of such deadly virus are as under:

Micro or bank specific impact of NPA:

- ✓ NPA is like a "double – edged knife" as it not only reduces net interest margin (as interest cannot be charged on such accounts), but also erodes current profit generated by other performing assets due to stringent provisioning norms on impaired loans (Selvarajan and Vadivalagan, 2012) [2]. Moreover it puts deterrent effect on the solvency and liquidity of the bank.

- ✓ Asset quality of a bank is measured inter-alia, in terms of the percentage of NPA to total advances and therefore a higher level of NPA leads to adverse comments and criticism by all stake holders which in-turn, adversely affects bank's image. It also de-motivates the staff and creates investor apathy and shakes the customer's loyalty.

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- *Gour Bandyopadhyay is currently pursuing PhD degree program in Management in West Bengal University of Technology, India, PH-919432083462. E-mail:gaur_banerjee@yahoo.co.in*

- ✓ Additional time and efforts required in management of bad loans involve indirect cost which a bank has to bear for no incremental gain. NPA creates a serious problem of asset liability mismatch as the money lent for a particular period if not recovered in time, meeting the matching liability will be extremely difficult and often becomes costly.
- ✓ The cost of financial intermediation by banks is high partly because of the cross subsidization of their NPAs. The immediate consequence of large amount of NPAs in the balance sheet of a bank is bank failure, (Hou, 2007) [3]. There are evidences that even among the banks that do not fail, there is a negative relationship between NPA and performance efficiency.

Macroeconomic/ industry impact of NPA:

- ✓ NPA implies bad loans and is a drag on bank's resources. Scarce resources of the bank get blocked, restricting the recycling to the productive sectors of the economy. Once the credit to various sectors of the economy slows down, the economy is badly hit. There is a slowdown in growth in GDP and consequent depression in the economy.
- ✓ Indirectly the burden of NPA is to be borne by the society as a whole. When government comes to rescue by way of infusion of capital to a sick bank due to erosion of capital on account of NPAs, the same comes out of government's budgetary resources which is contributed by the public in general, either in the form of tax revenues or from the hard earned savings of the investing public. In any case, the society is bearing the cost of these NPAs, (Sharma, 2005) [4].
- ✓ RBI Report on NPA stated that reduction in NPA should be treated as a national priority. Though Indian banks remained well-capitalised, concerns about the growing non-performing assets (NPAs) loomed large. Banks' exposure to the stressed power and airline sectors particularly added to deterioration in their asset quality, (India. RBI, 2012) [5].
- ✓ Management of NPAs, is as such sacrosanct to ensure effective re-cycling of funds, and improvement of bottom lines. Therefore, it is necessary that NPAs in a bank should be kept at the minimum possible level.

## 1.1 Statement of the Problem

Banking is a financial intermediary which mobilizes savings of the surplus units in the form of deposits and channelizes them in deficit units including agriculture, industry and services, as loans and advances. As a lending institution, NPA in banking business is an eventuality and cannot be avoided.

NPAs have dampening effect on banking system since long, though they were not in the public domain till early 90s (Khasnobis, 2006) [6]. Norms on NPA was implemented for the first time by RBI in 1992-93, when Gross Non Performing Asset (GNPA) of all PSBs were Rs 39253 crores, representing 23.18% of Gross Advances (GAs), which rose to Rs 112489 crores, representing 3.17% of the GAs as on March 2012. This

indicates low quality of credit portfolio in absolute terms. Such a high figure of loan defaults is directly eating away vitality of the PSBs and forces us to relook on the credit appraisal and follow up techniques applied by the banks. (Sharma, 2005) [4]. Therefore, managing asset portfolio has become the top most priority in PSBs in India, which requires focused and planned effort including forecasting future value of NPA and their effective management.

## 1.2 Defination of Terms

From perusal of balance sheet of any bank, it is observed that lion's share of aggregate asset are loans and advances and investments. Loan Assets of a bank are broadly classified as:

**A) Performing Assets:** Performing Assets or Standard Assets are those which do not disclose any problem or weakness with regard to repayment of principal and interest. In other words such assets do not carry more than normal risk attached to the business.

**B) Non Performing Assets:** Non Performing Assets (NPA), on the other hand are loan assets, which cease to generate income to the bank. It includes borrowers' defaults or delays in interest or principal repayment. A bank should classify an account as NPA only if the interest charged during any quarter is not serviced fully within 90 days from the end of the quarter. These assets have well defined credit weakness that jeopardize the liquidation of debts and may be characterized by distinct possibilities that bank will sustain some losses. In other words, an NPA may be defined as a credit facility in respect of which the interest and/or installment of principal has remained unpaid for a specified period of time. With a view to moving towards international best practices and to ensure greater transparency, it has been decided by RBI to adopt the "90 days' overdue" norm for identification of NPAs in India, from the year ended March 31, 2004.

Classification of NPAs are done, taking into account the degree of credit weaknesses, risks and extent of dependence on collateral security for realization of dues. NPA accounts are classified into following three categories.

**A) Sub Standard Asset:** A substandard asset is one, which has remained NPA for a period of less than or equal to 12 months. In such cases, the current net-worth of the borrower/guarantor or the current market value of the security charged is not enough to ensure recovery of the dues to the banks in full.

**B) Doubtful Asset:** An asset would be classified as doubtful if it has remained in the sub standard category for a period of 12 months. A loan classified as doubtful has all the weaknesses inherent in asset that were classified as substandard, with the added characteristic that the weaknesses make collection or liquidation in full, on the basis of currently known facts, conditions and values- highly questionable and improbable.

**C) Loss Asset:** A Loss Asset is one where loss has been identified by the bank or internal or external inspector or auditors or the RBI inspection as non recoverable and realizable value of securities is less than or equal to 10% of the outstanding but the amount has not been written off wholly. In other words, such an asset is considered uncollectable and of such

little value that its continuance as a bankable asset is not warranted, although there may be some salvage or recovery value. However, NPA account where there is potential threats to recovery on account of erosion in the value of security or non availability of security or fraud by the borrower, it should be straight way classified as Doubtful or Loss asset as appropriate.

**Public Sector Banks** refers to those commercial banks where the Government (Central and/or State and RBI) holds majority shares of the company and have absolute control in the management of the same. Private sector commercial banks, on the other hand refers to those banking companies where the Government has no stake either in ownership or in the management of the company
Public Sector Banks Group comprises of:
- ✓ State Bank of India and its Subsidiaries, popularly known as State Bank Group
- ✓ Other Nationalized Banks, popularly known as Nationalised Bank Group

**Gross Non Performing Asset** refers to the sum total of all loan assets that are classified as NPAs as per RBI guidelines as on balance sheet date and reflects the asset quality of a bank. It consists of all the nonstandard assets like as sub-standard, doubtful, and loss assets. In other words, GNPA is the amount outstanding in the borrower's accounts in the books of the banks other than the interest which has been recorded and not debited to the borrower accounts.

## 1.3 Theoritical Framework

Semi parametric regression is concerned with the flexible incorporation of non-linear functional relationships in regression analyses. Any application area that benefits from regression analysis can also benefit from semi parametric regression. Since a semi parametric regression model contains both parametric and non parametric parts, it offers a good compromise between parametric and non parametric regression models (Wu, 2010) [7].

Researchers devoted serious attention on semi parametric modeling of either independent or dependent time series data. Their focus on research interest has been primarily on estimation and testing of both parametric and non parametric components in semi parametric models. Interest of researchers also includes use of semi parametric methods in model estimation, specification testing and selection of non linear time series data. The semi parametric modeling technique comprises the two aims, flexibility and simplicity of statistical procedures by introducing partial parametric components. The flexibility of semi parametric modeling has made it a widely accepted statistical technique.

Semi parametric regression can also be of substantial value in complex real life problem. Such models reduce the complexity in the dataset to summarize that we can understand. Appropriate applications of such models ensure retaining essential features of the data set while discarding unimportant details and hence they aid sound decision making. Indeed,

these models are found to have more representative power many times, when compared against different performance criteria, to explain and model the real-life data situations. To capture the data characteristics, emanated from a real life data situation, in this research paper, we have employed Penalized splines technique of semi parametric approach.

Penalized splines have gained much popularity as a flexible tool for smoothing and semi-parametric modeling. Penalized splines are low-rank smoothers, i.e. amount of knots used for estimation is far less than the number of observations, which significantly reduces the numerical effort. According to Yao and Lee (2008) [8] there are two important components in fitting penalized splines – a) selection of the smoothing parameter and b) choice of the number of knots and their location.

The theoretical framework for developing a Penalized Spline fit as described by Nettleton (n.d.) [9], in his Lecture note 'Smoothing Scatterplots Using Penalized Splines' in Iowa State University is stated below:

Let us consider the model $y_i = f(x_i) + e_i$ where i=1,2....n

If f(x) is linear, then $f(x) = \beta_0 + \beta_1 x$

The linear model tries to approximate f(x) as a linear combination of two basis functions: where $b_o(x) = 1$ and $b_1(x) = x$, then
$$f(x) = \beta_0 b_0(x) + \beta_1 b_1(x)$$

Similarly, for a quadratic model i.e. $f(x) = \beta_0 + \beta_1 x + \beta_2 x^2$ we can write, $f(x) = \beta_0 b_0(x) + \beta_1 b_1(x) + \beta_2 b_2(x)$

Let us consider, $S_1(x) = (x - k_1)^+$
where, $k_1$ is a specified real value. Therefore f(x) can be approximated by $\beta_0 b_0(x) + \beta_1 b_1(x) + u_1 S_1(x)$

Where $u_1$ is an unknown parameter (like $\beta_0$ and $\beta_1$).
It may be noted that,
$$\beta_0 b_0(x) + \beta_1 b_1(x) + u_1 S_1(x) = \beta_0 + \beta_1 x + u_1 (x - k_1)^+$$

This function is a continuous function since it is a linear combination of continuous function. At the same time it is piecewise linear. It is simple example of linear spline. In this case $k_1$ is known as knot. In case of polynomial regression, we consider a linear spline model as a special case.

The linear spline function can become more flexible by adding more knots $k_1 \ldots k_k$ when
f(x) is approximated by, $\beta_0 + \beta_1 x + \sum_{j=1}^{k} u_j s_j(x)$
$$= \beta_0 + \beta_1 x + \sum_{i=1}^{k} u_i (x - k_i)^+$$

Thus the model becomes,
$$f(x) = \beta_0 + \beta_1 x + \sum_{i=1}^{k} u_i (x - k_i)^+$$

In many cases f(x) becomes non-smooth. Hence a less flexible (more smooth) estimate of f(x) is usually preferred. This can be obtained using penalized least squares.
For this two things are important
(i) Smoothing parameter and (ii) Penalty for roughness. It is for the researcher to choose proper smoothing parameter and the knots ($k_1, k_2 \ldots k_n$). If smoothing parameter is small we get a non smooth fit.

Now, there are few strategies for choosing the smoothing parameter.
A) Cross Validation–It is a general strategy for choosing smoothing parameter.

B) Generalized Cross Validation– It is an approximation to cross validation. The amount of smoothing can be selected by using the generalized cross validation function (Kageyama et al. 2004) [10].

Next the number of knots and their locations has to be decided. Ruppert (2002) [11] states that "there must be enough knots to fit features in the data, but after this minimum necessary number of knots has been reached, further increases in K often have little effect on the fit" (p. 740). Here, K means number of knots. Eilers and Marx (2004) [12] stress that "equally-spaced knots are always to be preferred", while Ruppert (2002) [11] emphasize utilization of quantile-based knots. In general, both approaches do the work equally well for most of the cases. Wu (2010) [7] points out that both the location and number of knots are equally important for splines as they determine the degree of smoothing. Knots can either be placed uniformly or all the distinct time point can be used as knots. The percentile based knot placing rule can also be used. Thus it can be said that a good fit can be obtained if there are enough knots. Penalization prevents a fit that is too rough even when there are many knots.

In our case the semi-parametric model is fitted using the SemiPar package from the R statistical system. SemiPar is a simple tool to construct a nonlinear regression. This package provides a convenient way to fit splines to data using R. In the SemiPar package, f is estimated using penalized spline smoothing.

For univariate smoothing, SemiPar's default basis function is radial: $| x - \kappa_k |^p$, where $\kappa_k$ is the location of the $k^{th}$ knot, and p is the degree. The default degree for the radial basis is 3, so the default function is:

$$f(x) = \beta_0 + \beta_1 x + \sum u_k |x - \kappa_k|^3 \quad \text{where, k=1,...... K}$$

## Diagnostics Procedures

Best fit in semi parametric regression is found with proper variable selection as well as the choice of smoothing parameter. The residuals from a semi parametric regression fit can be employed as a useful diagnostic tool as described below. Such residuals are used in order to determine whether the smooth curve adequately incorporates all of the interesting structure in the data. The residuals are scrutinized for systematic patterns that may remain after a hypothesized structural representation has been fitted to the empirical data.

## Residuals vs Predictor Plot

The semi parametric regression residuals are defined as the difference between the observed values of the Y variable, and the corresponding fitted values for the respective occurrences of the X variable values: $E_i = y_i - \hat{f}(x_i)$

The equation above is very similar to the familiar formula for calculating residual values in regression analysis. However, there is one important difference. The K knots used to find the semi parametric regression curve are imaginary values which are usually different from the n observed values of the independent variable, X. Therefore, the fitted values for the empirical observations, $\hat{f}(x_i)$ are typically obtained from the model.

Once the semi parametric regression residuals are calculat-

ed, they are plotted against either the corresponding fitted values or (more commonly) the values of the original X variable. Then, a semi parametric regression curve is fitted to the points within the residual plot. This new application of the semi parametric regression smoother should produce a flat line located at the zero value on the vertical axis in the residual plot. The reasons are as follows. The semi parametric regression residuals measure the variability in Y that remains after the dispersion of the fitted values (and hence, the smooth curve) is taken into account. Any systematic functional dependencies between X and Y should be picked up by the original smooth curve fitted to the bivariate data. To the extent that the semi parametric regression fitting process does so successfully, there should be no discernible patterns of any kind among the residuals; this, in turn, would produce a horizontal line when a smooth curve is fitted to the residual plot. If the plot does not reveal any kind of systematic relationship (whether linear, cubic, quadratic, etc.) between the residuals and the predicted values, we may say penalized spline model is appropriate for our data.

## Quantile Comparison Plots of the Residuals

This plot shows the residual plot from the original penalized spline curve that is fitted to the data. The points in this figure are obtained by plotting the penalized spline residual values (on the vertical axis) against normal norm quantiles plot (on the horizontal axis) to check the presence of outliers in the data variables. The plot is also used to detect departures from normality in the residual distribution.

## Normal Q-Q Plot

A Q-Q plot ("Q" stands for quantile) is a probability plot, which is a graphical method for comparing two probability distributions by plotting their quantiles against each other. First, the set of intervals for the quantiles are chosen. A point (x, y) on the plot corresponds to one of the quantiles of the second distribution (y-coordinate) plotted against the same quantile of the first distribution (x-coordinate). Thus the plot obtained in this way represents a Q-Q Plot.

If the quantiles of the two distributions being compared are similar, the points in the Q-Q plot will approximately lie on the line y = x. If the quantiles of the two distributions differ only in their location or scale, the points in the Q-Q plot will fall on or near line, y = ax + b. The slope a and intercept b are visual estimates of the scale and location parameters of the theoretical distribution. The Q-Q plot can provide an graphical assessment (rather than reducing to a numerical summary) of "goodness of fit" and hence can be used to compare two theoretical distributions. A normal Q-Q plot compares a randomly generated, independent data-set plotted on the vertical axis to a standard normal deviate population plotted on the horizontal axis. The linearity of the points on the plot suggests that the randomly generated data are normally distributed.

## Goodness of Fit Statistics
### $R^2$ value

When a semi parametric regression curve is fitted to data, attention is usually focused on the shape of the resultant curve

because that feature is most revealing of the structure within the data. However, it is also useful to consider how well the smooth curve characterizes the empirical data values. This latter phenomenon is usually called 'goodness of fit', although that term is only partially appropriate in the case of semi parametric regression. A summary fit statistic similar to an $R^2$ value can be obtained by taking the ratio of the sum of squares in the semi parametric regression fitted values to the total sum of squares in the dependent variable.

**Decision Rule:**

A relatively high $R^2$ value would lead to the conclusion that the smooth curve summarizes nearly all of the total dispersion in the dependent variable.

### F statistics

The concept of degrees of freedom for semi parametric regression models is not as intuitive as for linear models since there are no parameters estimated. Nonetheless, the degrees of freedom for a semi parametric regression model are a generalization of the number of parameters in a parametric model. The analogy to the linear model is not perfect, but approximate. Using the approximate degrees of freedom, we can carry out F-tests to compare different estimates applied to the same dataset; Compare different levels of polynomial fits; Compare the smoothed model to a linear model etc. Determining the degrees of freedom is also necessary for constructing confidence envelopes around the fitted curve. Unlike in linear model, the degrees of freedom for semi parametric regression model are not necessarily whole numbers.

F-tests comparing the residual sums of squares for alternative nested models can be carried out in exactly the same way as for linear models. These tests are only approximate because of the approximation of the degree of freedom.

Perhaps the most useful aspect of semi parametric regression is that it allows us to test for nonlinearity by contrasting it with a linear regression model. In general for semi parametric regression, if we are testing two nested models, we can construct the usual F-ratio as:

$$((RSS_0 - RSS_1)/(df_{res1} - df_{res0}))/(RSS_1/(n - df_{res1}))$$

Where $RSS_0$ is the residual sum of squares for the smaller model (linear model in our case), and $RSS_1$ is that for the larger model (semi parametric univariate penalized spline smoothing). Also $df_{res,0}$ is the degree of freedom for the $RSS_0$ and $df_{res,1}$ is the degree of freedom for the $RSS_1$.

**Decision Rule:**

If p-value of F test is less than 0.05 then we conclude that there is no linear relationship between response and predictor variables.

### 1.4 Objective of the Study

In view of the relative importance of NPAs in banking sector in India in general with PSBs in particular, it is perceived that a comprehensive study in this area should be made. The present study is a humble endeavour to examine various aspects of NPAs in selected PSBs. The specific objectives embodied under the research are as follows:

i)   to examine the overall trends of NPAs  and to explore the dynamicity of NPA as the variable under study over time

in six selected PSBs;

ii)  to develop a forecasting model with the help of univariate dataset of GNPA (dependent variable) and Time (independent variable)

### 1.5 Methodology

The study undertakes an empirical approach to analyse the movement of NPAs in six selected PSBs India over the last two decades, based on secondary data related to the strategic banking variable, ie, NPAs. The secondary data have been collected from RBI publications,  Prowess Database of Centre for Monitoring Indian Economy and the Annual Reports of the selected PSBs.

The study includes examination of movement of NPA over time, developing forecasting model for medium term with NPA as dependent variable. For the purpose of our analysis, a time series data-set on parameter GNPA for 17 years i,e March 1996 to March 2012 for six selected PSBs have been  captured and analysed by using SemiPar package of R software in order to draw relevant inference.

To examine dynamicity of NPA over time as stated in the first objective, semi parametric, nonlinear regression models have been invoked by employing Penalised Spline technique and the best fitted model to represent the trend has been obtained in case of each data-set. The forecasted values have been generated based on the said best fitted model as stated in objective number two.

### 1.6 Hypothesis

Null Hypothesis ($H_0$): There is no linear relationship between Non Performing Assets (response variable) and time (predictor variable).

Alternate Hypothesis ($H_1$): There is a linear relationship between Non Performing Assets (response variable) and time (predictor variable).

### 1.7 Review of Literature

In view of the seriousness of the problem, numerous research studies have been conducted on different issues concerning credit risks including NPAs.

Berger and Young (1997) [13] develop an econometric model for forecasting NPAs in a commercial bank, to test the hypotheses regarding relationship among loan quality, cost efficiency and bank capital. The paper suggests that problem loans precede reductions in measured cost efficiency; that measured cost efficiency precedes reductions in problem loans; and that reductions in capital at thinly capitalized banks precede increase in problem loans. Hence, cost efficiency may be an important indicator of future problem loans and problem banks.

Misra and Dhal (2001) [14] examine the factors responsible for increasing levels of NPAs and observes that NPLs are influenced by three major sets of economic and financial factors, i.e., terms of credit, bank size induced risk preferences and macroeconomic shocks. A Panel Regression model for forecasting Gross NPA Ratio has been developed. The empirical results from Panel Regression Models suggest that terms of credit variables have significant effect on the banks' non-

performing loans in the presence of bank size induced by risk preferences and macroeconomic shocks. The study also observes that factors like maturity of credit, better credit culture, favorable macroeconomic and business conditions lead to lowering of NPAs. Business cycle may have differential implications adducing to differential response of borrowers and lenders.

Yao and Lee (2008) [8] states that:

> "Due to its simplicity and effectiveness for handling different semi parametric smoothing problems, penalized spline regression has recently become a popular tool for solving various estimation problems, ranging from environmental modeling (Wood and Augustin, 2002) to longitudinal and functional data analysis (Harezlak, Ryan, Giedd & Lange, 2005; Yao & Lee, 2006) to remote sensing imaging (Clarke et al., 2006). When comparing to smoothing splines, an attractive property of penalized spline regression is the ease for conducting statistical inference (Ruppert et al., 2003)". (p 259)

Salkowski (2008) [15] in his work has given examples of using spm function of the SemiPar package to fit the semiparametric model where temperature deviation is a function of the year.

Ahmed (2010) [16] attempts to investigate empirically the asset quality and loan recovery of Indian commercial banks and establishes a relationship between growth in advance and growth in NPA of a bank. The paper also examines various factors that affect NPAs of a commercial bank and presents a multi regression model in forecasting NPA of a bank with a few strategic banking variables like Priority Sector Advances, Credit Deposit Ratio, NPA to Advance Ratio as independent variables. It is observed that Priority Sector Advances, Credit-Deposit Ratio, Capital Adequacy Ratio and NPA to Advances Ratio may not be considered as a very good determinant of dependent variable, ie, Non Performing Assets. The researcher however concludes that NPA is an important parameter to assess the financial health of a banking company as it reflects asset quality, credit risk, and efficiency in the allocation of resources in deficit sectors and therefore various initiatives have been taken to contain growth in NPAs.

Dash and Kabra (2010) [17] examine determinants of Non Performing Loans in India from both macro economic and strategic banking variables. With the help of regression analysis an econometric model is developed using a panel data set covering 10 years (1998-99 to 2008-09) to examine the relationship between non-performing loans and several key macroeconomic and bank specific variables, for predicting future value of NPA. The study observes that the real effective exchange rate and the changes in real income as reflected by growth in real GDP, have a significant positive and a significant negative relationship respectively with NPAs. It also finds that commercial banks that are aggressive and charge relatively higher interest rates incur greater NPLs.

Gupta and Jain (2010) [18] examine factors like credit spreads, collateral, long-term structures and commitments between borrowers and lenders over time, which are responsible for the cropping up of distressed asset from the perspec-

tive of the financiers. An econometric model has been captured to predict NPAs, taking into account bank level micro economic variables in the sample banks. The study suggests a multi pronged approach for solution to the problem of NPAs by addressing policy issues, strategic issues, restructuring issues, legal issues, reporting issues, supervisory issues, operational and procedural issues.

Rawlin and Sharan (2011) [19] make a sincere attempt to develop a forecasting model for the NPA percentage at both the gross and net level from the Total Assets of one of the India's largest PSB. A strong correlation is observed between gross and net NPA% and the total assets suggesting that the estimate of gross and net NPA can be made from total assets, by fitting to linear and non linear models. A non linear curve estimation model, is found best fit by virtue of best $R^2$ value linking both gross and net NPA to advances provide the best curve fit and the least deviation from actual values. Thus by studying total assets an overall picture of the banks NPA level can be ascertained and effective strategy can be formulated to address the most formidable problem in the banking industry.

Thiagarajan et al. (2011) [20] in their empirical study make an attempt to predict the determinants of the credit risk expressed in terms of NPA in the banking sector in India by using an Econometric model. The study identifies both macro economic as well as micro economic bank specific variables and observes a high $R^2$ for both Public and Private Sector Banks which is a reflection of the fitness of the model and its predictability. For the purpose of the study descriptive statistics including mean and standard deviation of the selected variables have been captured. It is inferred by looking at the graphical representation of non performing loans and the rate of GDP Growth and inflation that there is an inverse relationship between GDP Growth and NPA while a positive correlation between inflation and NPA for the recent past 2 years.

Siraj and Pillai (2012) [21] examine the impact of gross advance and total deposit on incremental NPA with the help of simple regression analysis. A multiple regression model has also been developed with NPA as a dependent variable with total deposits and total advances as independent variable to examine the total effects of these variables in addition to NPAs of the bank. The study observe that increased level of addition to NPA still remain a major concern for banks in India.

## 1.8 Scope of the Study

Banking industry in India comprise of the PSBs and the Private Sector Banks (PrSBs). PSBs consists of the State Bank of India (SBI) and its five subsidiaries, collectively termed as the State Bank Group and nineteen nationalized banks, commonly referred to as Nationalised Bank Group and one other PSB, ie, IDBI Bank. The twenty PrSB's are further subdivided into Old PrSB Group and New PrSB Group. In addition to these PrSB there exists thirty six Foreign Banks (FBs), privately owned with registrar office located abroad.

PrSBs and FBs are particularly excluded from the study, as they are not strictly comparable with PSBs and they account for less than 16% and 5.30% of Gross NPAs of banking system in India respectively, as on March 2012. The Regional Rural Banks (RRBs) are also excluded from the present study as their

operations are confined to target groups in rural and semi ur-ban areas.

As the concept of NPA was first introduced in 1992, there-fore their post reform 1st balance sheets became available one year later ie, in, 1992-93. However NPA data of all PSBs are not available for 1992-93, 1993-94 and 1994-95 (only aggregate PSB figures are available since 1992-93). This provides justifi-cation for 1995-96 as the starting year in the present study. Further, the study covers the period upto 2011-12, i,e the lat-est year till the dataset is available.

For the purpose of the study, we have taken one large sized PSB {State Bank of India (SBI)}, two medium sized PSBs {Pun-jab National Bank (PNB) and Central Bank of India (CBI)} and three small sized PSBs {State Bank of Travancore (SBT), UCO Bank (UCO) and Syndicate Bank (SB)}.

## 1.9 Limitation of the Study

The study makes an attempt to examine empirically trends of NPAs for six selected PSBs. However studies revealed macro economic factors like global recession, high rate of inflation have significant influence on NPAs of a bank which is beyond the scope of our study.

Time series GNPA data is available for seventeen years for six selected PSBs. Therefore the dataset can be said to be very small under any standard.

As the study is exclusively on secondary data, it is subject-ed to following shortcomings:

- The researcher has least control over how the data was collected.
- There may be biases in the data that the researcher doesn't know about.
- Output from such dataset may not exactly fit the re-searcher's research questions.

## 1.10 Significance of the Study

Unimpressive asset quality is a matter of great concern to not only the lenders but also all concerned including the people at large (society). High level of NPA implies scarce resources of the bank get blocked, restricting the recycling of funds in the productive sectors of the economy. Once the credit to various sectors of the economy slows down, the economy is badly hit, resulting in increase in unemployment and poverty. Moreover mounting menace of NPA raises the cost of credit, makes banks more averse to credit risk and as a result, genuine small and medium entrepreneurs are denied of credit, which unfor-tunately, throttle their enterprising spirits as well.

Again, when a 'NPA burdened PSB' becomes sick with negative net worth, government comes forward to rescue by way of infusion of capital to the sick bank. Such financial as-sistance comes out of government's budgetary resource which is contributed by the people in general, either in the form of tax revenues or from the hard earned savings of the investing public. In any case, the society is bearing the cost of these NPAs.

Despite the importance of monitoring non-performing loans, forecasting on parameter GNPA have only received moderate attention in literature. This study contributes to the existing literature by modeling the parameter GNPA of six selected PSBs in India using semi parametric Penalized Spline technique.

Given the forecasting models, the paper is capable of providing insights into the stability of the financial system and is also of immense practical significance for policy mak-ers/regulators/financial engineers/researchers in terms of developing plans to minimise the volume of NPAs in the fu-ture. By examining trends in NPA time series data and fore-casting NPA for medium term in six selected PSBs, as at-tempted in the study, a bank will be in a position to initiate corrective actions as appropriate towards improving level of distress asset in the bank resulting in a great relief for the economy and society. Such forecasts enable the policy makers to judge whether it is necessary to take any measure to influ-ence the relevant economic variables. Given its association with bank failure and financial crisis, the evaluation of non-performing loans (NPLs) is of great importance and should therefore be of interest in a developing country like India. Ar-eas of future application of such modeling in the banking in-dustry are enumerated below:

i)   Future values of GNPA, along with other strategic bank-ing variables, can be forecasted by other banks from the past performance using semi parametric approach which has been illustrated in the forecasting section of the re-search paper.

ii)  With the help of these forecasted values the banks can formulate policy initiatives through planning and budg-eting to bridge the gap between the tolerable level of NPA and forecasted level of NPA.

iii) Such models can be used to mitigate risk associated with credit portfolio as an early warning system.

iv)  Such forecasts enable the policy makers to judge whether it is necessary to take any measure to influence the rele-vant economic variables.

v)   Motivational schemes like promotion/ fringe benefits can be employed through performance benchmarking based on forecasted value of GNPA.

vi)  The models can be used as a performance measurement means for the selected PSBs. Some of the major areas are given as under:
   a. Reviewing the profitability of the bank to reflect changes in policies and their underlying economics along with harmonization of these policies with risk management methods,
   b. Determining the nature and impact of the critical factor that have greatest influence on the bank's perfor-mance,
   c. Redefining the profitability of the banks by effective management of NPA and harmonizing new policy ini-tiatives with NPA management, managing the criticali-ties to align the components of performance manage-ment processes with forecasting.

## 2 BODY

### 2.1 Background of the Study

A number of factors make the NPAs in PSBs in India an inter-esting subject for study.

- First, during the 1990s, India underwent liberalization of the banking sector with the objective of enhancing efficiency, productivity, and profitability (India. RBI, 1991)[22].
- Second, the banking sector underwent an important transformation, driven by the need for creating a market-driven, productive, and competitive economy in order to support higher investment levels and accentuate growth (India. GOI, 1998) [23].
- Third, studies on NPAs in banking industry in emerging economies like India has great relevance, as it dampens the bottom-lines and thereby poses a serious threat to the very existence of the most important sector in propelling the desired growth and development of the economy.

In view of the seriousness of the problem, numerous research studies have been conducted on different issues concerning credit risks in banks including NPAs. However, empirical works on NPA problems in PSBs are inadequate. The exhaustive review of literature on NPA demonstrates that majority of the research work has been undertaken on aggregate PSBs data with primarily focus on the following areas:

i) Chaitanya (2004) [24] and Reddy et al. (2006) [25] examine the trends of NPA in PSBs.
ii) Berger and Young (1997) [13], Misra and Dhal, (2001) [14], Ahmed (2010) [16], Dash and Kabra (2010) [17], Gupta and Jain (2010) [18], Rawlin and Sharan (2011) [19], Thiagarajan et al. (2011) [20] and Siraj and Pillai (2012) [21] predict future value of NPAs with the help of simple/ multiple regression models. Graham and Humphrey (1978) [26] observe that forecasting NPA employing data of past loans are generally more accurate than less parsimonious models.

However empirical work on individual bank-wise trend study and modeling for the purpose of forecasting future value on NPA in PSB has seldom been attempted. It is against this backdrop that the present study is undertaken to fill up this gap and make a modest contribution in the field of management of NPA in banks in India. Accordingly, examination of movement of NPA over time and forecasting the same for medium term with the help univariate time series data by employing semi parametric (Penalised Spline Curve Fit) for six selected PSBs has been attempted in the paper.

## 2.2 Semiparametric smoothing by Penalized spline

The SemiPar package has algorithms for selecting knots, if knots are not provided by the user. The smoothness of the fit can also be left to SemiPar, but users can control smoothness in two ways. In a univariate fit, the smoothing parameter is the ratio of the smoothing variance to the error variance. Large values of the smoothing parameter ($\sigma^2_\varepsilon$ /$\sigma^2_u$) produce smoother functions. Alternatively, users can specify the degrees of freedom for the fit. The more degrees of freedom in the fit, the less smooth the function is.

Now the GNPA dataset as dependent variable with time (year as 1996,1997,1998….2012 taken as 1, 2, 3, ….17 respectively) as independent variable are processed through the SemiPar package of R software and summary statistics for non linear components are given below.

TABLE 1

SUMMARY STATISTICS FOR PENALIZED SPLINE MODELS

| Bank | df | spar | knots |
|------|------|-------|-------|
| SBI | 4.955 | 1.707 | 3 |
| SBT | 4.774 | 3.039 | 3 |
| SB | 4.767 | 3.079 | 3 |
| UCO | 4.674 | 3.515 | 3 |
| CBI | 4.69 | 3.441 | 3 |
| PNB | 4.911 | 2.169 | 3 |

*Note this includes 1 df for the intercept*

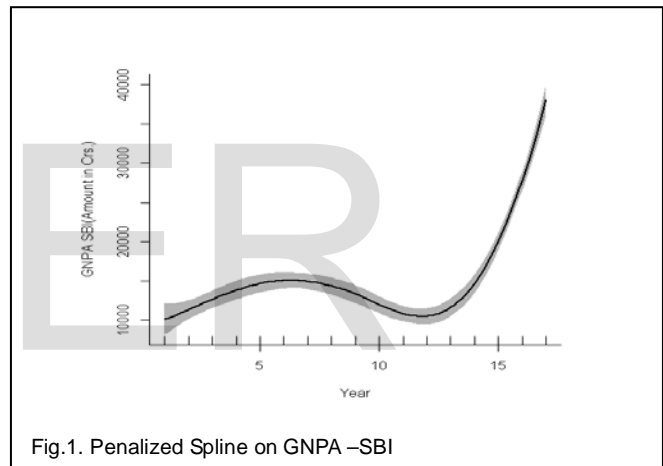The graphs and plots of the semi parametric models (smoothing by penalized spline) for six selected PSBs are given below:
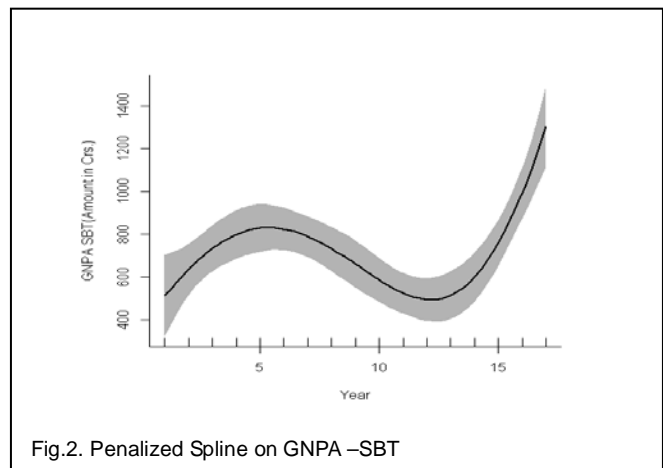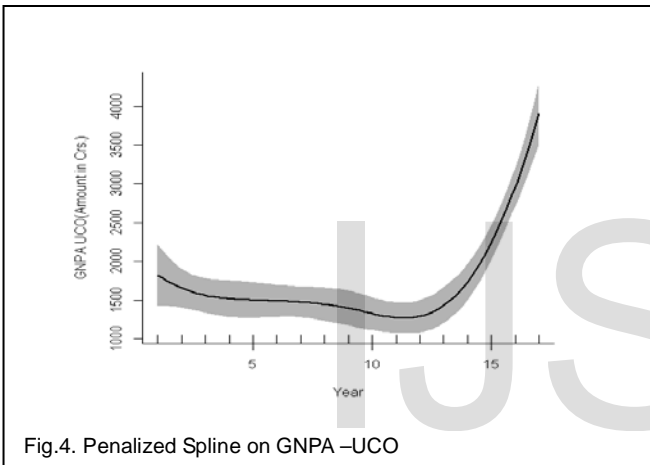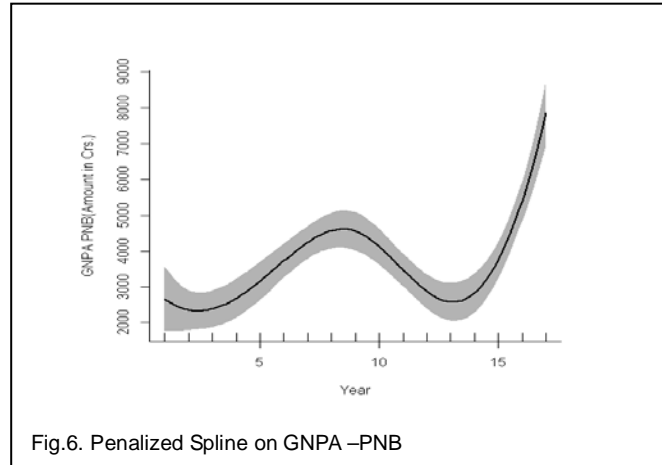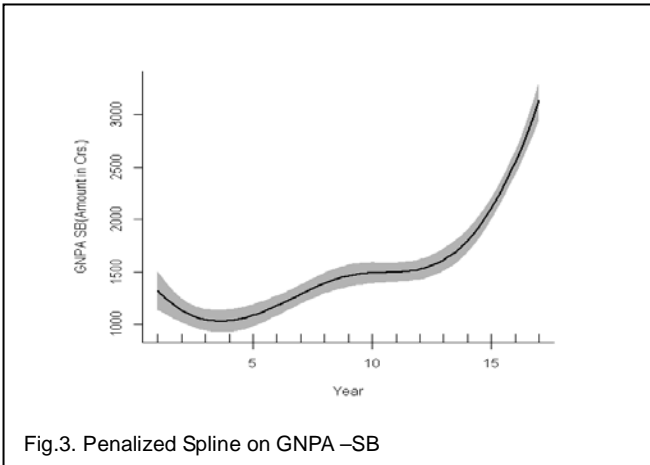


Fig.1. Penalized Spline on GNPA –SBI



Fig.2. Penalized Spline on GNPA –SBT

Fig.3. Penalized Spline on GNPA –SB



Fig.4. Penalized Spline on GNPA –UCO



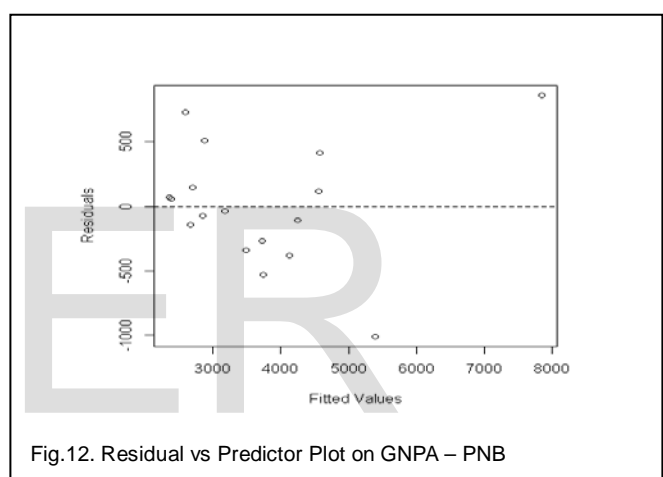Fig.5. Penalized Spline on GNPA –CBI



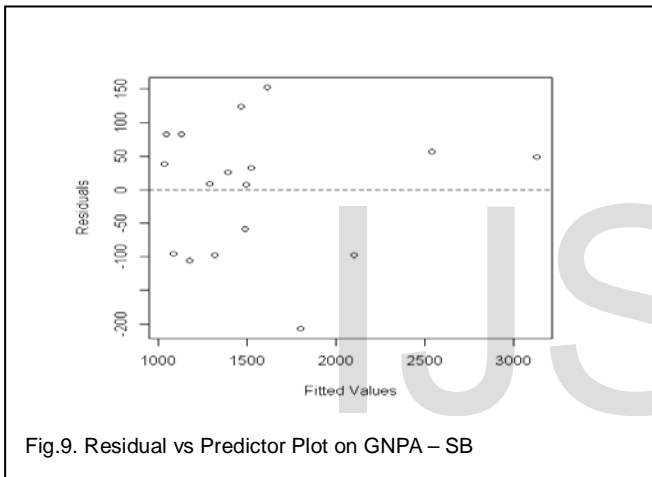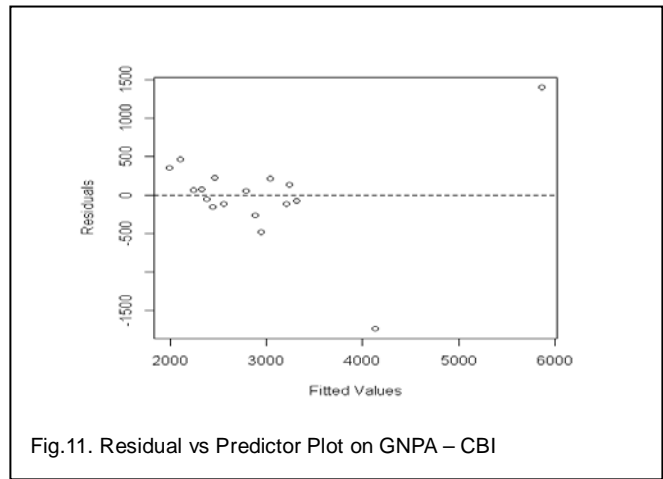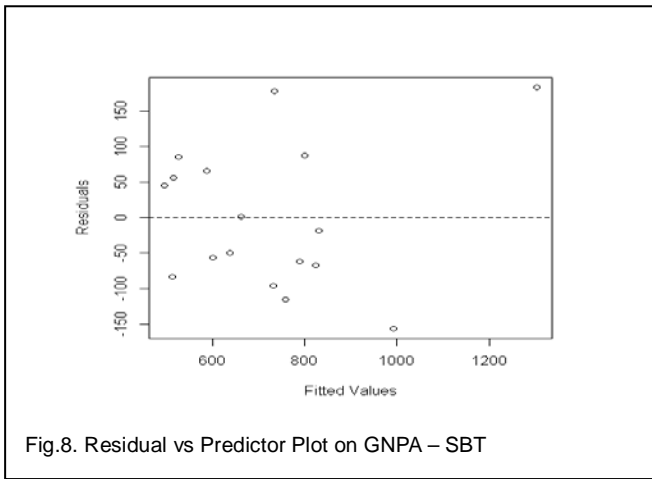Fig.6. Penalized Spline on GNPA –PNB

The GNPA and time (year) dataset are plotted on vertical axis and horizontal axis respectively. The findings from the above figures are detailed below:

1. The general diagonal orientations of the points suggest that GNPAs are highly correlated to Year for all the banks.
2. The curves follow the central tendency of the Y variable's (GNPA) values across the range of the X variable (Time). In doing so, the curvilinear nature of the relationship between GNPAs and Time is revealed immediately.
3. These curves are obtained without any prior specification about the functional form of the relationship. Instead, the sigmoid (i.e. 'S-like') shape of the curve is produced by the semi parametric penalized spline regression procedure. The slopes of the fitted curves are negative at some Years on the horizontal axis.
4. These curves clearly show that a linear model would provide a misleading depiction of the relationship between GNPA values and time (year).
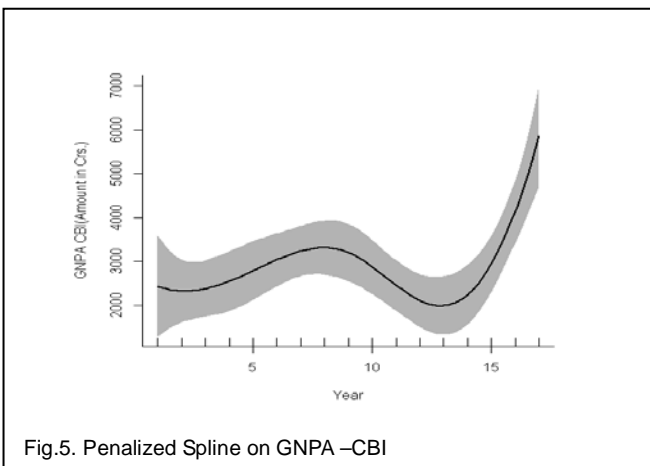
## 2.3 Diagnostics – Residual vs Predictor Plot



Fig.7. Residual vs Predictor Plot on GNPA – SBI

Fig.8. Residual vs Predictor Plot on GNPA – SBT



Fig.11. Residual vs Predictor Plot on GNPA – CBI



Fig.9. Residual vs Predictor Plot on GNPA – SB



Fig.12. Residual vs Predictor Plot on GNPA – PNB



Fig.10. Residual vs Predictor Plot on GNPA – UCO
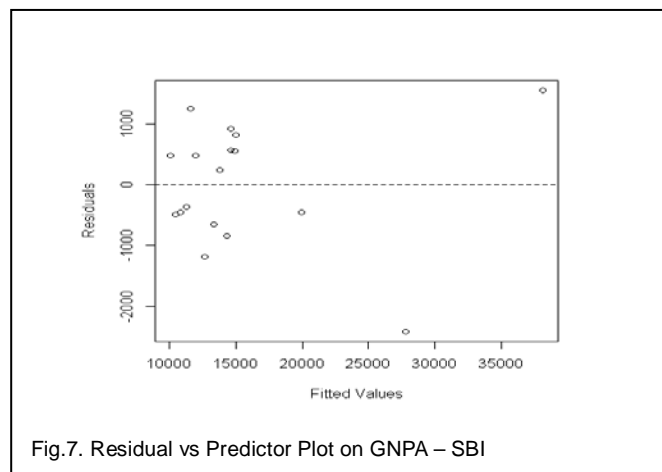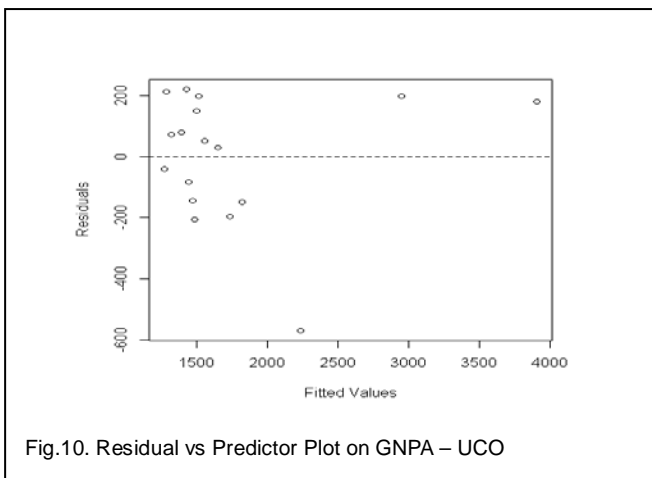
The dotted horizontal line is a visual baseline corresponding to residual value of zero. The above 'Residual vs Predictor Plot' (Fig. 7 to 12) shows that the residuals appear randomly scattered around zero indicating that the penalized spline model describes the data well. It can also be stated that the model provide adequate representation of the GNPA bivariate dataset. Looking at the plots above we can say that for our GNPA dataset, the plots exhibit the absence of relationship between residual and predicted value and therefore it can be concluded that penalized spline model exhibiting simple curvelinear relationship is appropriate for our GNPA dataset.

## 2.4 Diagnostics – Quantile Comparison plot of residuals
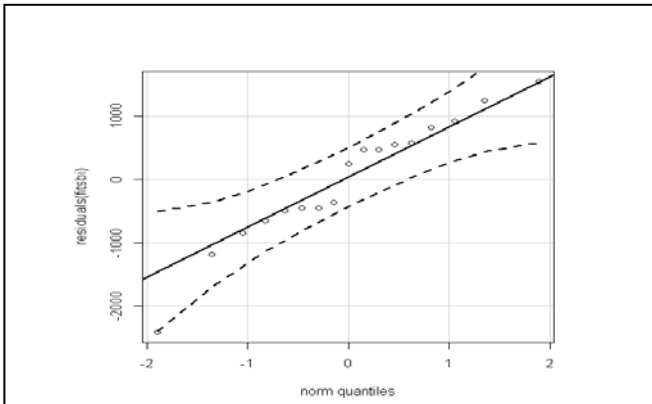


Fig.13. Quantile Comparison Plot on GNPA -SBI
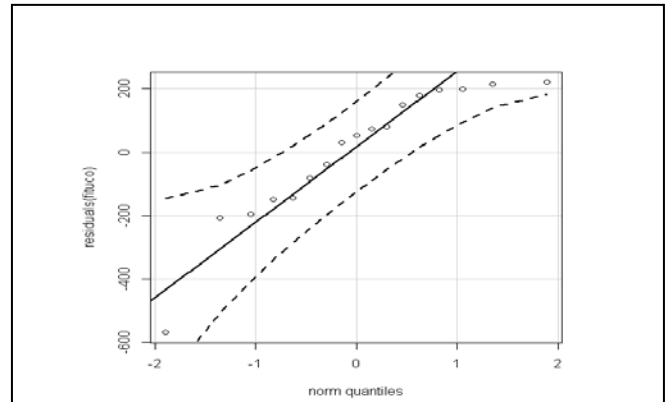


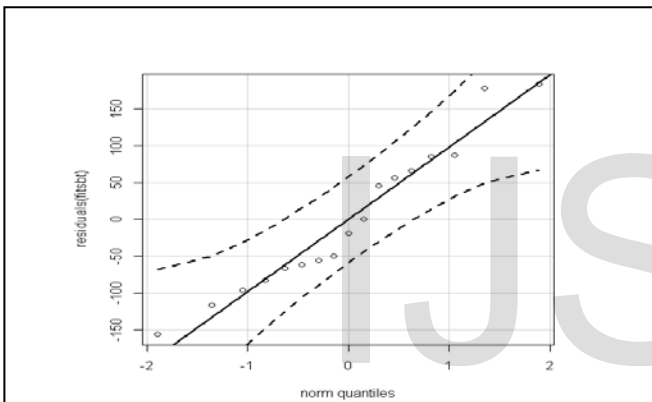Fig.16. Quantile Comparison Plot on GNPA -UCO



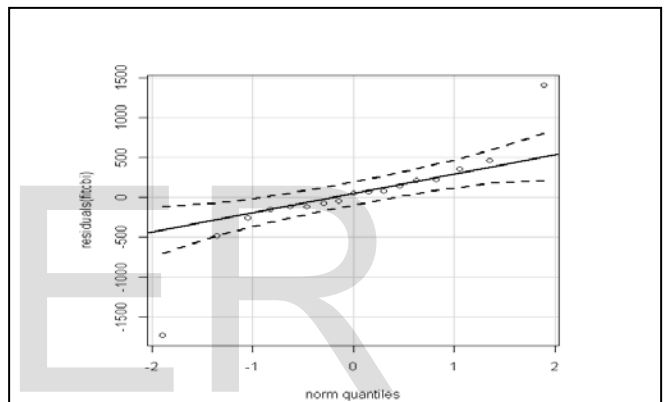Fig.14. Quantile Comparison Plot on GNPA -SBT



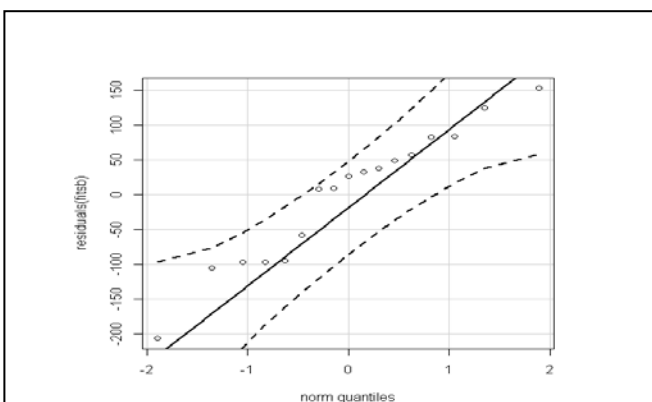Fig.17. Quantile Comparison Plot on GNPA -CBI
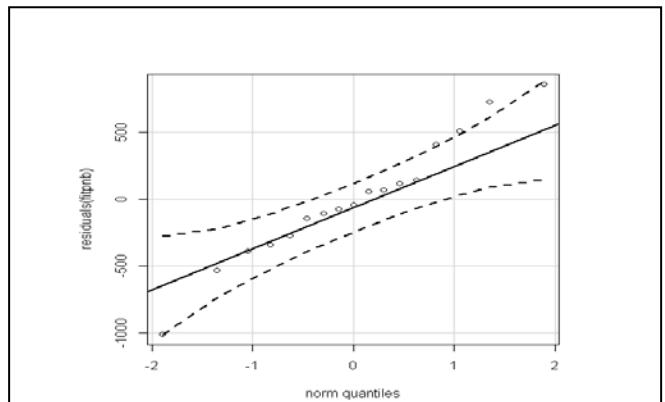


Fig.15. Quantile Comparison Plot on GNPA -SB



Fig.18. Quantile Comparison Plot on GNPA -PNB

From the above figures it is evident that in case of CBI and PNB outliers are present. Rests of the banks (SBI, SBT, SB and UCO) are free from outliers.
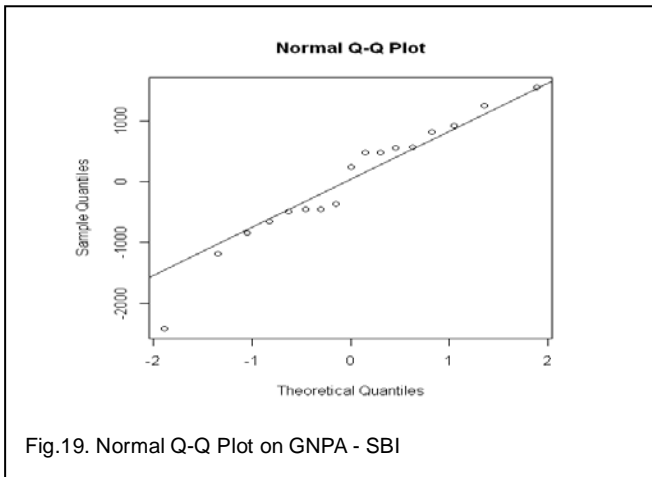
## 2.5 Diagnostics – Normal QQ plot



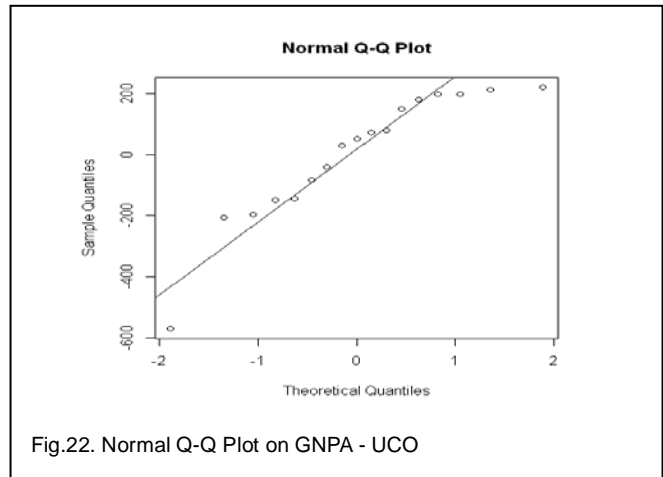Fig.19. Normal Q-Q Plot on GNPA - SBI



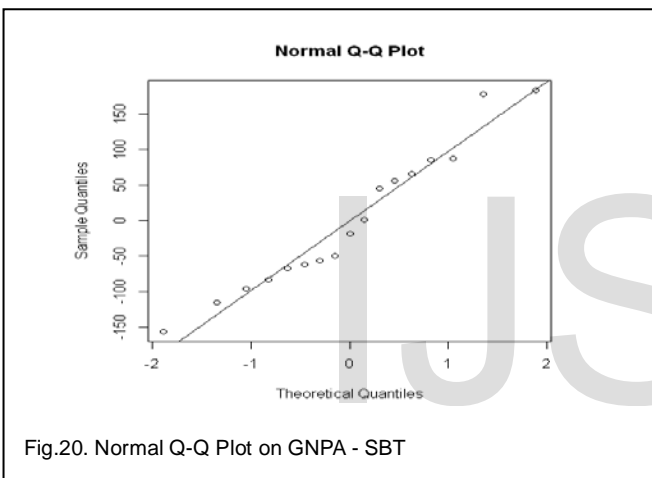Fig.22. Normal Q-Q Plot on GNPA - UCO
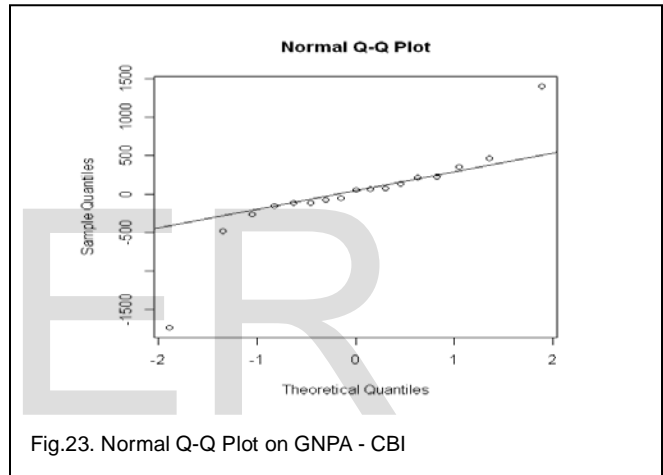


Fig.20. Normal Q-Q Plot on GNPA - SBT



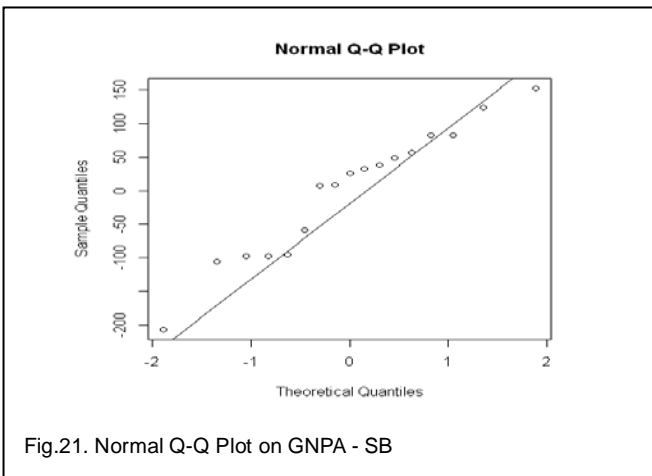Fig.23. Normal Q-Q Plot on GNPA - CBI
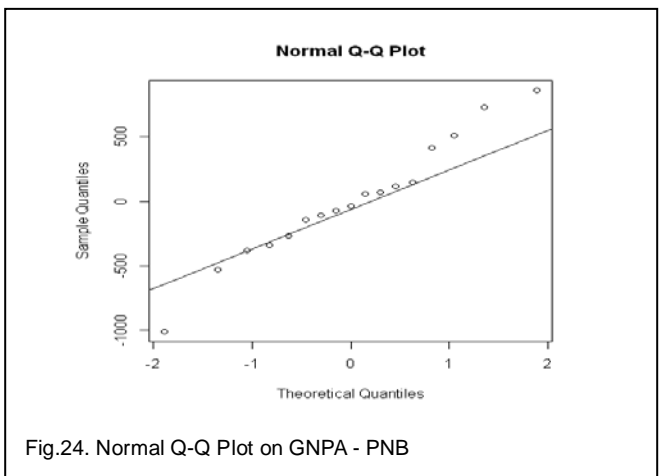


Fig.21. Normal Q-Q Plot on GNPA - SB



Fig.24. Normal Q-Q Plot on GNPA - PNB

The q-q plot has been done to test the normal distribution of the residuals for all the banks. It may be observed that the residuals in respect of GNPA dataset of all banks with the exception of SB and PNB follow approximately normal distribution.

## 2.6 Goodness of fit statistics

$R^2$ value and significance of F value generated by the software is given below.

TABLE 2

SUMMARY STATISTICS OF PRECISION CRITERIA FOR SELECTED PSBS ON PARAMETER GNPA

| Bank | $R^2$ | F-Statistics | P-Value |
|---|---|---|---|
| SBI | 0.98133 | 222.8523 | 8.981621e-11 <0.05 |
| SBT | 0.826295 | 31.981 | 1.246618e-05 <0.05 |
| SB | 0.972258 | 79.26349 | 6.786588e-08 <0.05 |
| UCO | 0.918562 | 65.12458 | 2.185709e-07 <0.05 |
| CBI | 0.741757 | 18.19112 | 0.0002406547 <0.05 |
| PNB | 0.904853 | 44.067 | 1.78319e-06 <0.05 |

From the above table it is apparent that $R^2$ value is very high for SBI, SB, UCO and PNB while it is moderately high for for SBT and CBI. Hence we may say that the smooth curve summarizes nearly all of the total dispersion in the dependent variable.

The p-value of F test is less than 0.05 and therefore we may conclude that there is no linear relationship between response and predictor variables, which establishes the null hypothesis that there is no linear relationship between Non Performing Assets (response variable) and time (predictor variable).

## 2.7 Aspect on Forecasting

The main purpose of constructing a time series model is to forecast. In this case forecasting has been done by extrapolating models beyond the period over which they are estimated. The semi parametric models (Penalised Spline Curve Fit) obtained based on our dataset from 1996 to 2012, have been extrapolated beyond the sample period to get the forecasted values for the years, 2013, 2014 and 2015 with respect to the parameters GNPA are given in the Table – 3.

TABLE 3

FORECAST VALUE FOR PARAMETER GNPA

| Bank | Forecasted value (Rs in Crores) | | |
|---|---|---|---|
| | 2013 | 2014 | 2015 |
| SBI | 51322.97 | 67531.26 | 86941.35 |
| SBT | 1701.95 | 2185.965 | 2760.908 |
| SB | 3896.22 | 4847.518 | 6005.538 |
| UCO | 5121.76 | 6618.705 | 8420.167 |
| CBI | 8200.55 | 11178.68 | 14854.43 |
| PNB | 11234.3 | 15598.62 | 21036.14 |

Forecasted Values of GNPA for three years (2013, 2014 and 2015) of all the selected PSBs exhibit an alarming phenomenon of continuous upward rise, which puts question mark on the wisdom and integrity of the top management in PSBs in India in handling credit portfolio. Such a situation undoubtedly de- serves immediate and serious attention on the part of the regulators to relook into the practices of credit appraisal and monitoring of credit in PSBs in India.

## 3. Conclusion

NPA is one of the most important banking parameters for determining soundness and efficiency of the monitory system in an economy. In an effort to examine trends in NPA and develop a forecasting model for the purpose of analysis and control of bad loans in selected PSBs, various approaches and techniques may be used by the researchers and experts. In this paper, penalized spline, a very popular semi parametric technique has been fitted to GNPA data sets for six selected PSBs and it has been observed that these semi parametric models are very much relevant and useful as it enhances the precision level of the models in respect of parameter GNPA in six selected PSBs in India.

The study finds that NPA in PSB in India can be adequately captured by semi-parametric regression (penalized spline). In future the researchers can use this study as a reference to examine the trend of NPA for other PSBs and PrSBs and develop appropriate forecasting models and further compare these results among different group of banks for examining the relative strengths and weaknesses of different banks. The researchers may also explore multivariate modeling taking clue from this study which primarily focuses on univariate modeling.

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