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An Effective Financial Efficiency Model for Sustainable Growth of Primary Agriculture Credit Society In Rural Bengal -An Application Of Multi-Objective Fuzzy Non-Linear Goal Programming

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Abstract:
After the globalization and financial liberalization, financial inclusion has become an essential pre-requisite for achieving 'Inclusive Growth' as well as accelerating people economic and social life. Primary Agriculture Credit Society plays a dynamic role in enabling the development of financial system as well as generates job orientation in the rural market of the rural economy to achieve 'financial inclusion', which is the prime objective of policy makers in our economy. The basic financial services at affordable prices and their social support to the weaker section of the society are questionable due to global uncertainty. Without changing it's main regular functions, how a PACS can sustain in future through applying different policies is a big question? Due to the various constraints like lack of infrastructure, environmental problem, geographical problem, basic education and local political problem, PACS are not able to reach the needy people in rural areas.

On the basis of this background this paper attempts to make a comprehensive study of financial institutional parameters to minimize the cost of operation and maximize profit by using Multi-objective Fuzzy Non-linear Goal Programming. On the basis of primary data collected from 354 PACS from different district of West Bengal, by using a predefined questionnaire, regression analysis is used to identify the main indicator of financial performance, using SPSS
(21) software. LINGO software used to study the Multi-objective Fuzzy Non-linear Goal Programming.
The study found that both internal financial planning as well as external non-financial support for customer growth became an important issue for sustainable development of each PACS in our state. It is also observed that to achieve "Financial Inclusion", PACS became the financial backbone of our rural areas and can sustain in future if they are ready to reduce their nonperforming assets and increase in managerial performance for customer satisfaction in all level.

Key word: *–PACS, Financial Inclusion, Multi-objective Fuzzy Non-linear Goal Programming, Regression Analysis.*

JEL Classification: ***E60, G01, G2***

1. INTRODUCTION:

A review of literature suggests that the PACS (Primary Agriculture Credit Societies) works towards a positive vision: that of a widespread, reasonably equitable social welfare, which is sustainable for the coming generations. They help to change the rural life by ensure a safe and clean habitat, with a minimum level of health, education, economic opportunity, social status, political representation and cultural self-expression for all. The PACS has also been a space where there is a constant innovation in terms of new ideas as well as new technologies. The All India Rural Credit Survey Committee (1960) analyzed the first fifty years of performance of the cooperatives and came to the conclusion

that cooperatives have been a 'failure' but also expressed that 'no form of credit organization will be suitable in the villages except the cooperative society' and proclaimed that 'Co-operation has failed, but co-operation must succeed.' Again after one hundred years of the cooperative existence, when the Vaidyanathan Committee met for the first time, there was a debate on whether cooperatives are needed to be revived or should they be allowed to wither away. According to the recommendations of the Capoor Committee, the Vikhe Patil Committee and the Vaidyanathan Committee, the only way out was to link financial restructuring with stringent conditionality of regulatory and institutional reforms to revive the existing Primary Agricultural Credit Societies (PACS) in India. Another development that is going to have a far reaching impact on the cooperative systems is the recommendation of the Committee on Financial Sector Assessment (Chairman: Shri Rakesh Mohan) to allow only licensed banks to operate in the cooperative space by 2012. Reserve Bank announced in its Annual Policy Statement for 2009-10 that a road map would be worked out for achieving this objective in a non-disruptive manner in consultation with NABARD. After consulting NABARD, it was decided to license those banks which have achieved a CRAR of 7 per cent and not committed CRR and SLR default (barring stray incidents) during the last two consecutive years (i.e., 2007 and 2008).[1] This signals that cooperative banks today have one last chance to either become professional and well managed entities or quit.

In spite of operating under several constraints, 63% of the District Central Cooperative Banks and 40% of the Primary Agriculture Credit Societies (PACS) under the short-term cooperative credit structure were in profit in the year 2007-09. As on 31 March 2017, there were 95,595 PACS with a total membership of 13.12 crore, of which, 40% (5.20 crore) were borrowing members. As compared to the previous year, while the total PACS membership increased by 3%, the borrowing membership of PACS increased by 12.55%. As on 31 March 2017, the deposits mobilised stood at 1, 15, 884 crore and total loans outstanding by all the PACS was 1,70,459 crore . During 2016–17, as per available data with respect to 84,622 PACS, 46,586 PACS earned profit of 6,472 crore and the remaining 38,036 PACS incurred loss of 3,209 crore. In the long- term cooperative credit structure, 62% of the PACS are under the category of 'viable' and 29% are under 'potentially viable' category (NAFSCOB, 2017). There are lessons to be learnt from these profits -making cooperative institutions for the rest of the cooperative credit sector especially for PACS in rural Bengal. It is evident from the fact that the share of PACS in total institutional credit to agriculturists has accounted for more than 60 percent in the year 2017. Hence a comprehensive study on the financial performance of PACS and its contribution towards socio economic development became an important issue in our economy.

Objective of the study:

The performance and contribution of PACS in India and especially in West Bengal towards economic development of their stakeholders has remained an unexplored social landscape in the literature. Therefore, the objective of this paper is to identify the financial parameters which helps to sustain the growth of PACS and their sustainable profit in future. The analysis of secondary data financial institution especially PACS and cooperative bank at West Bengal, it has revealed that the financial institution is incurring a huge loss in terms of external pressure from local government and their consequence lower rate of loan processing and infrastructural problem. If the institution can control these two parameters, it has enough opportunity to reduce substantial amount of its loss. Also, minimization of political and social influence has been taken as important decision variables for this study.

RESEARCH METHODOLOGY:

With the above stated objectives in mind, the researcher has collected secondary data for the period 1991 to 2013 of different Regional Rural Bank and Cooperative Bank from West Bengal, India. The

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analytical part of the research has explained the way to improve the financial viability of a financial institution in terms of efficiency and cost effectiveness through the application of Fuzzy Non-Linear Goal Programming and has been tested out by applying Zimmermann's model. In the proposed mathematical model the researchers have considered maximization of profit as the basic objective which in turn can help the banking institution to achieve its goal of minimization nonperforming assets and increase in managerial performance for customer satisfaction in all level of operation. Fuzzy non-linear optimization problem has become a cornerstone theory in understanding of an optimization problem. A market is called efficient which maintains the sustainability of its rate of growth of profit by utilizing its all resources optimally. Financial sector is not an exception to it. To establish the above fact, we need to determine the dynamic relationship among the rate of growth of profit and the decision variables like rate of growth of members ($\boldsymbol{\Delta M_t}$) , rate of growth of loan ($\boldsymbol{\Delta L}$) by applying
different alternative policy to pull the customer and rate of growth of macro environment compulsions ($\boldsymbol{\Delta Ex_t}$) by applying the following regression equation:

$$\boldsymbol{\Delta \pi_t} = \boldsymbol{\alpha_1} + \boldsymbol{\alpha_2}.\boldsymbol{\Delta M_t} + \boldsymbol{\alpha_3}.\boldsymbol{\Delta Ex_t} + \boldsymbol{\alpha_4}.\boldsymbol{\Delta L_t} + \boldsymbol{\varepsilon_t} \ldots . (\mathbf{1})$$

Where, $\Delta\pi_t$is the rate of growth of profit, $\Delta M$is the rate of growth of members, $\Delta L_t$is the rate of growth of loan, $\Delta Ex_t$is the rate of growth of macro environment compulsions, $\alpha_i$is the different parameters for the model, ε_t is the error term which is normally distributed with zero mean and constant variance.

To obtain the ordinary least square estimate of the parameters we rewrite the equation as:

$$\Delta\pi_t = X_t\hat{\alpha} + \varepsilon. \ldots . (2)$$

The $\hat{\alpha}$ can be determined as;

$$\hat{\alpha} = (X_t{}' X_t)^{-1} X_t{}' \Delta\pi_t$$

The variance –covariance matrix can be written as**;**

$$var - cov(\hat{\alpha}) = \begin{vmatrix} var(\hat{\alpha}_1) .. cov(\hat{\alpha}_1, \hat{\alpha}_2) .. cov(\hat{\alpha}_1, \hat{\alpha}_3). \\ |cov(\hat{\alpha}_2, \hat{\alpha}_1) .. var(\hat{\alpha}_2) .. cov(\hat{\alpha}_2, \hat{\alpha}_3)| \\ cov(\hat{\alpha}_3, \hat{\alpha}_1) .. cov(\hat{\alpha}_3, \hat{\alpha}_2) .. var(\hat{\alpha}_3) \end{vmatrix}$$

For the purpose of achieving the goal of sustainability of profit no specific value of decision variables can be taken. Instead we should consider a range of values in this regard. Although, this seems logical and direct, it does not specifically identify the effective range of the decision variable which determines the sustainable rate of growth of profit. If we want to look at the variance – covariance matrix of the decision variables, the result would show an indirect relationship among the rate of growth of profit and variance of the decision variables. This should suggest that the accuracy of expected rate of growth of profit will achieve when we minimize the variance of the decision variables. Based on these above arguments, it is hypothesized that an optimization model will be applicable to determine the range of different decision variable which maintain the sustainable rate of growth of profit.

The traditional optimization problem can be described by the following bi-objective mathematical programming,

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Max, $Z_0 = \Delta\pi_t = \sum^3_1 \alpha_t X_t$

And

Min $Z_1 = Var(\sum_{t=1}^{3} \alpha_t X_t)$

Subject to $X_t > 0$ t=1, 2, 3.

Where X_t the decision variables, and α_t is the estimated coefficient of the regression model. The above multi-objective program can be written as:

Max:

$$Z_0 = \Delta\pi_t = \alpha_1.\, \Delta M_t + \alpha_2.\, \Delta L_t + \alpha_3.\, Ex_t$$

Min:

$$Z_1 = Var\,(\sum_{t=1}^{3} \alpha_t X_t) = \sum_{t=1}^{3} X_t^2\, var(\alpha_t) + 2 \sum_{1\le i\le t\le 3} X_i X_t\, cov(\alpha_i.\alpha_t)$$

Fuzzy Programming Technique to Solve Multi-Objective Problem (MOP)

A general multiple objective non-linear programming problem is of the following form :

Minimize

$f(x)=[f_1(x), f_2(x), \ldots\ldots, f_K(x)] \ldots\ldots (3)$

Subject to $x \in S$,

where $S = [x/x \in R^n, gi(x)(\le, =, \ge]$

Where $\{a_i, i = 1, 2, \ldots\ldots m\}$ where $x = [x_1, x_2, \ldots\ldots, x_n]^T$ is an n-dimensional vector of decision variables, $f_i(x)$, $i \in I$, are the maximization objectives ; $f_j(x)$, $j \in J$ are the minimization objectives and $I \cup J = \{1, 2, \ldots\ldots, K\}$. It is noted that all functions $f_k(x)$ and and $g_i(x)$ ($k = 1, 2, \ldots K$ and $i = 1, 2, \ldots m$) can be linear or non-linear.

all functions $f_k(x)$ and and $g_i(x)$ ($k = 1, 2, \ldots K$ and $i = 1, 2, \ldots m$) can be linear or non-linear.

In the last two decades, many fuzzy programming techniques have been developed for solving multi-objective problems. Zimmermann[1978] first showed that fuzzy programming technique can be used nicely to solve the MOP problem using maxmin operator of Bellman Zadeh [1970].

To solve the MOP problem by fuzzy technique we first have to assign two values U_k and L_k as upper and lower bounds of the k^{th} objective for each $k = 1, 2, \ldots K$. Here, L_k = aspired level of achievement, U_k = higher acceptable level of achievement and $d_k = U_k - L_k$ = the degradation allowance. The steps of the fuzzy programming technique are as follows:

Step-1 : Each objective function $f_k(x)$ of the MOP problem (3) is optimized separately subject to the constraints of the problem (1). Let these optimum values be $f_k^*(x)$, ($k = 1, 2, \ldots K$).

Step-2 : At each optimal solution of the three single-objective programming problem solved in step-1, find the value of the remaining objective functions and construct a pay-off matrix of order K□K as follows:

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Table1: Pay-offmatrix for Fuzzy Variables

	F1(x)	**f2(x)**	**…..**	**fK(x)**
(x^1)	$f1^*(x^1)$	$f2(x^1)$	…..	$f2(x^1)$
(x^2)	$f1(x^2)$	$f2^*(x^2)$	……	$fK(x^2)$
…..	……	……	……	……
(x^K)	$f1(x^K)$	$f2(x^K)$	……	$fK^*(x^K)$

From the pay-off matrix, find lower and upper bounds f_k^L, f_k^U, (k = 1, 2, … K) as follows.

f_k^L = Min { $f_k(x^1)$, $f_k(x^2)$, …., $f_k(x^K)$} and f_k^U = Max{$f_k(x^1)$, $f_k(x^2)$, …., $f_k(x^K)$} for all k = 1, 2, …, K.

Step-3 :To solve this crisp problem by Zimmermann [1978] method, we take the membership functions $\mu_{f_i}(x)$, i ∈ I and $\mu_{f_j}(x)$, j ∈ J respectively of the maximization of objective functions $f_i(x)$, i ∈ I and minimization of objective function $f_j(x)$, j ∈ J, I∪J = {1, 2, …., K} in the linear form as follows:

$$\mu_{f_i}(X) = \begin{cases} 1 & \text{if } f_i(x) > f_i^U \\ \dfrac{f_i(x) - f_i^L}{f_i^U - f_i^L} & \text{if } f_i^L \le f_i(x) \le f_i^U \\ 0 & \text{if } f_i(x) < f_i^L \end{cases}$$

$$\mu_{f_j}(X) = \begin{cases} 1 & \text{if } f_j(x) < f_j^L \\ \dfrac{f_j^U - f_j(x)}{f_j^U - f_j^L} & \text{if } f_i^L \le f_i(x) \le f_i^U \\ 0 & \text{if } f_j(x) > f_j^U \end{cases}$$

Step-4:Using above membership functions, we formulate and solve the crisp non-linear programming model following the methods due to Zimmermann (1978) and others.
Zimmermann model can be written as:

Maximize: α ……(4)

subject to:

$$w^1\left(\frac{Z_0^U - Z_0}{Z_0^U - Z_0^L}\right) \ge \alpha,$$

$$\& \; w^2\left(\frac{Z_1^U - Z_1}{Z_1^U - Z_1^L}\right) \ge \alpha,$$

$$\sum_{i=1}^{n} x_i = 1,\ x_i \ge 0,\ i = 1, 2, \ldots, n,$$

$$0 \le \alpha \le 1 \quad \text{and} \quad w^1 + w^2 = 1.$$

Where w^1,and w^2 are the weights for the optimization of the model.

NUMERICAL ILLUSTARTION:

The secondary data used for numerical illustration have been collected from Annual Reports of different Primary Agriculture Credit Society for the period 2015 to 2019. We have taken rate of growth of profit as dependent variable$\Delta\pi_t$and ΔM is the rate of growth of members, ΔL_t is the rate of growth of loan amount, $\Delta Ex_t$is the rate of growth of macro environment compulsions are treated

as independent variables or different decision variables in our model. A multi variate regression model is determined as:

$\wedge$

$\Delta\pi$ = 36.4 + 0.25. ΔM + 0.75ΔEx + 0.385ΔL -……..(5)

(3.58) (4.52) (3.15) (6.5)

And the variance –covariance matrix as follows:

Table 2: Variance-Covariance Matrix

	ΔM	ΔEx_t	ΔL
ΔM	**1**	**0.49**	**-0.94**
ΔEx_t	**0.49**	**1**	**-0.31**
ΔL	**-0.94**	**-0.31**	**1**

For the above data, the following pay-of matrix (Table-3) is constructed and then optimum result will be discus by using Fuzzy non-linear program.

Table 3: Pay-Off Matrix

	Z0	**Z1**
(M^1, Ex^1, L^1)	**38.65**	**23.56**
(M^2 Ex^2 L^2)	**49.75**	**2.35**

Table 4: Zimmermann's model

	W^1	W^2	Z0	Z1	L	M	Ex
1	**0.8**	**0.2**	**38.65**	**23.56**	**0.32**	**0.18**	**0.16**
2	**0.6**	**0.4**	**49.75**	**2.35**	**0.58**	**0.76**	**0.45**
3	**0.5**	**0.5**	**25.33**	**9.84**	**0.58**	**0.44**	**0.47**
4	**0.2**	**0.8**	**5.61**	**2.95**	**0.34**	**0.28**	**0.46**

CONCLUSIONS:

This study establishes a set of fuzzy multiple criteria for policy makers to improve the efficiency in terms of financial viability of any PACS for their profit maximization by optimal use of its available resources.

From table-4, we have observed that a policy maker can assign a certain and deterministic weight for the different goals or objectives, especially to maximize the rate of growth of profit but in reality there cannot be a fixed relationship between the dependent variable and the decision variables which is established by the regression equation. Here all parameters in equation (5) are statistically significant (all t-values are statistically accepted alternative hypothesis) and therefore we may conclude that all variables are explained the rate of growth of profit according to their assigned magnitude and sign. However, in order to make an efficient decision, we need to set an optimum value which gives us a deterministic measurement of each variable.

From the table 4 Zimmermannes model in section we can conclude that when we consider (0.6, 0.4) weight for the two objective function:

(i) Maximization of rate of growth of profit, (Z0)

(ii) Minimization of variance-covariance,

we get the optimal value of each objective function. (Z1)
In this scenario the rate of growth of members has got highest amount of importance as it is assigned 76 percentages whereas growth rate of macro environment compulsions has got lowest importance by assigning only 46 percentages.
Similarly, when we consider (0.8, 0.2) weight for the different objective functions, we get another optimal value of each objective function where the rate of growth of loan has got highest amount of importance as it is assigned 32 percentage whereas growth rate of macro environment compulsions has got lowest importance by assigning only 16 percentage.
Therefore, in order to improve the efficiency of a financial institution, the Policy makers may concentrate on the following:-

- Maximizing sales of financial product and other product and service by providing the best way of customer satisfaction.
- Controlling macro environment compulsions like political and local government problem and managerial problem.
- Overall managerial performance.

Therefore, if the institution can control above parameters, it has enough opportunity to reduce substantial amount of its loss. Also, minimization of political and social influence has also play an important role in improving the banking performance in local area and maintaining high level of growth of members with high sales may lead to sustain a profit.

LIMITATIONS:

This study has three limitations as mentioned below:

First, the entire study is based on published secondary data of a PACS and Cooperative Bank in West Bengal, India which is operate speciaaly in rural areas. The published data represents combined performance of both good and bad perfomere at a time. Indiviaul data is not available. Therefore, the picture depicted regarding performance of a financial instituion based on two segment may not be universally pertinent.
Second, from Table 4 we have observed that the decision variable i.e. growth rate of loan (L) has got negligible weight even though it has explained the rate of growth of profit significantly compaired to other decision variables. This may be due to lack of availability of requisite data.
Third, the entire study has been conducted from an economist's point of view. As it is highly uncertain and consumer sensitive industry, there may be conflicting perspective about the problem between an socialist, banker and an economist.

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