

Slack Based Measure of Technical Efficiency of District Agriculture Cooperative Marketing Societies in Andhra Pradesh

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Abstract- This study contributes to an understanding of the technical efficiency and ranking of twelve district agriculture cooperative marketing societies in the state of Andhra Pradesh in India. The analysis of technical efficiency- ratio of weighted outputs to weighted inputs - is based on the primary data collected from the district cooperative marketing societies (DCMS) for the period 2018-19 to 2022-23. This paper identifies three inputs (fixed assets, total expenditures, and own fund) and two outputs (total turnover and investments) to evaluate the efficiency levels of district cooperating marketing societies. The technical efficiency estimates derived from the super efficiency SBM model of Tone (2002) are found to be lower than those obtained from super efficiency model of Anderson-Peterson (1994), resulting in alterations to the ranking of cooperative marketing societies. The larger efficiency estimates under the Anderson-Peterson model are attributed to the significant amount of input and output slacks, resulting from the assumption of the radial direction of the model. The efficiency estimates under SBM model is found to be more robust. SBM super efficiency estimates showed Gunter DCMS, West Godavari DCMS, and East Godavari DCMS as the top-performing district cooperative marketing societies. Their high efficiency ranking is due to diverse business operations, dependence on own funds, safe investments in financial instruments, effective control in management costs and consistent profits earnings.

Key Words- DACMS- District Agriculture Cooperative Marketing Society, SBM -Slack Based Measure, DEA-Data Envelopment Analysis, CCR-Charnes Cooper-Rhodes, DMUs-Decision Making Units, RBKs-Rythu Bharosa Kendras, CAGR-Compound Annual Growth Rate

I.INTRODUCTION

The objective of this study is to find out the technical efficiency of twelve district agriculture cooperative marketing societies in the state of Andhra Pradesh, one of the southern states in India. The estimates of technical efficiency for cooperative marketing societies would provide valuable information for the decision makers on the level of utilization of resources in obtaining mix of outputs and would suggest a potential improvement towards targeted inputs and targeted outputs. This study has employed methodology of super efficiency model advanced by Anderson and Peterson (1993) and Slack Based Measure (SBM) super efficiency developed by Tone (2002) for estimation of efficiency scores of cooperative marketing societies. The SBM super efficiency estimates within the framework of data envelopment analysis (DEA) of Charnes-Cooper-Rhodes (CCR 1978) provides for ranking super-efficient units among the efficient cooperative marketing societies. With fewer firms -referred to as Decision Making Units (DMUs) – SBM super efficiency model can differentiate among efficient firms. The technical efficiency estimates derived from SBM model provide referent DMUs as benchmarks for resource allocation for inefficient firms in the sample.

II.PROBLEM AND THE SCOPE OF THE PRESENT STUDY

District Agriculture Cooperative marketing societies (DCMS) in the state of Andhra Pradesh are facing

several challenges. The real challenge before them is declining volume of business in traditional activities such as in sales of agricultural inputs like seeds, fertilizers, farm machinery and in procurement and sales of farm produces. Over the period, role of district cooperative marketing societies as monopoly procurement agencies on behalf of the state government had diminished. The main reason for the decline in the procurement of agriculture commodities by DCMS is there has been surplus production in agriculture commodities leading to decontrol in many of these commodities. Despite the decontrol in movement of commodities and free movement of agriculture goods across inter-states and intra-states, the marginal and small farmers could not obtain better prices for their products; their bargaining capacity with traders in the marketplace is limited as the farmers are widely dispersed and are not organized or unionized. In this context, the cooperative marketing societies are expected to play a crucial role. Despite diminished role and limited market power, the cooperative marketing societies can reduce transaction costs for small and marginal farmers, standardize agricultural products, and ensure better prices based on quality and correct weights and measures. The cooperative marketing societies are anticipated to safeguard small and marginal farmers from income instability, as they remain vulnerable to fluctuations in market forces. In the light of farmers' income instability and high transaction cost for farmers, it is important to examine the role of cooperative marketing societies with a focus on resource-use efficiency in providing better services to farmers. The basic questions to be asked are: Are district cooperative marketing societies optimally using their fixed assets and financial resources to generate higher output, such as total earnings and investments? Is there potential for enhancing the utilization of resources for higher productivity and efficiency?

III. NEED FOR EFFICIENCY ANALYSIS OF DISTRICT COOPERATIVE MARKETING SOCIETIES

Numerous empirical studies have employed the methodology of Data Envelopment Analysis (DEA) to assess the efficiency levels of various organizations across diverse sectors such as banking, insurance, educational institutions, hospitals, manufacturing,

transportation, and other service industries. Emrouznejad and Yan (2018) provide comprehensive survey on developments that had taken place in the areas of empirical and theoretical areas of data envelopment analysis in the forty years since the publication of seminal paper by Charnes-Cooper and Rhodes (1978). Emrouznejad, Brzezicki, and Lu (2025) reviewed the current state of research on the empirical works relating to use of super efficiency and SBM super efficiency models. Banker et al (2015) examined the performance and sensitivity of super efficiency model of A-P for decision making units with different configuration of inputs and output values. Liu (2009) applied for the SBM model for commercial banks and found the efficiency estimate corresponds with the anticipated results. The present study is the first of its kind using slack-based measures of technical efficiency to understand the efficiency levels of agriculture cooperative marketing societies in India.

IV. ORGANIZATION OF THE PAPER

The paper is organized into eight sections. Following an initial overview of the subject matter and the nature of the study in section I, section II details the sources of data used for this research. It also includes information on the performance metrics of district cooperative marketing societies. Section III discusses the correlation between variables and specifies inputs and outputs. Section IV provides the theoretical structure of super-efficiency and SBM super-efficiency models. Section V highlights the differences in efficiency scores and rankings of each Decision-Making Unit (DMU) as derived from the super efficiency model and the SBM super efficiency model for the period 2018-19 to 2022-23. Section VI provides comparative analysis of inputs and outputs slacks obtained under super efficiency model and SBM super efficiency model for specific year 2022-23. Section VII outlines the input and output targets, as well as the reference DMUs for both efficient and inefficient DMUs, using the SBM super efficiency model. Section VIII summarizes the results and provides policy conclusions.

V. ACKNOWLEDGEMENT

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Data

The data for SBM super efficiency for DMUs have been collected from twelve-district agriculture cooperative marketing societies in Andhra Pradesh in the months of January to April 2024. Besides, the researchers had detailed discussions with the functionaries of cooperative marketing societies relating to institutional aspects of the cooperative marketing societies in the districts. The data have been collected with an objective to evaluate the price and non-price competitions from private traders in the districts. It is known that the state government's reform measures relating to development of new institutional arrangement like Rythu Bharosa Kendras (RBKs) to deliver agriculture inputs and other essential goods to rural population and their expanded operations into procurement of agriculture produce from farmers have affected adversely the volume of trade hitherto conducted by the district cooperative marketing societies (DCMS) and consequently their profitability. Data were culled out from the annual balance sheets, trading accounts and profit & loss accounts of the twelve district cooperative marketing societies for five years from 2018-19 to 2022-23.

VI. DESCRIPTIVE ANALYSIS OF DCMS

Table 1 shows summary measures for twelve cooperative marketing societies, covering procurement, sales, reserve funds, investment, total earnings, expenditures, and profit and losses.

Procurement of agriculture commodities

The compound annual growth rate (CAGR) of procurement of commodities by twelve DCMS was negative at 13.15% for the period 2019-2023. East Godavari DCMS, Guntur DCMS, and West Godavari DCMS have registered steady growth in procurement of commodities in the past five years. Seemingly, Vijayanagaram DCMS, Visakhapatnam DCMS and

Srikakulam DCMS had registered high procurement growth rates during this period albeit low base i.e. lower value in the base year compared to terminal year yielding higher compound annual growth rate. Rest of the DCMS registered double digit negative growth in procurement of agriculture inputs and outputs.

Sales of agriculture commodities

The analysis of growth for sales of commodities by the cooperative marketing societies aligned with the growth trends in procurement. The compound annual growth of sales for five years (2019- 2023) was negative at 14.23%. While Srikakulam DCMS and Visakhapatnam DCMS had registered CAGR respectively 13.37% and 5.36%, Vijayanagaram DCMS had shown CAGR of 32.02% due to lower base effect, i.e. the value for terminal year is larger than the low value in the base year. In contrast, the largest DCMS namely Guntur DCMS, West Godavari DCMS and East Godavari DCMS respectively had registered modest compound annual growth rate of 3.33%, 2.79% and (-) 2.90%. Other cooperative marketing societies has registered negative compound annual growth rates in the past five years.

Profitability of cooperative marketing societies

Guntur DCMS has not only registered high net profit but has also recorded the highest growth rate over a five-year period, with a compound annual growth rate (CAGR) of 25.17%. West Godavari district DCMS has registered second highest net profit growth. Chittoor DCMS has registered third largest growth rate at around 3% CAGR for five-year period. The highly inflated growth rate for Vijayanagaram DCMS (122% CAGR) could be attributed to a lower base effect. The average compound annual growth rate for net profit for whole period 2019 to 2023 was negative at 22.334%. Visakhapatnam DCMS and Ananthapur DCMS experienced continuous losses in the last five years. In 2022-23, four DCMS out of twelve, had incurred losses. Visakhapatnam, Kurnool, Kadapa, and Ananthapur DCMS reported significant losses in 2022-23. The DCMS which reported high net profits earnings are Guntur DCMS, East Godavari DCMS, Vizianagaram DCMS, Chittoor DCMS, and West Godavari DCMS. Their success lay in diversified business operations and are operating in relatively advanced and in resource-rich regions. The performance of Kurnool DCMS and Kadapa DCMS

had deteriorated in 2022-23 over 2018-19, i.e. From profit-generating institutions to loss-incurring entities.

Discussion on variables for efficiency analysis

The estimation of super efficiency and SBM super efficiency for district cooperative marketing societies uses three independent variables: (a) Fixed assets, (b) Total expenses, and (c) Own Funds; and two outputs: (d) Total earnings and (e) Investment. These variables among other issues are discussed below:

(a). Fixed Assets

Fixed assets are measured in value terms. In the cooperative marketing societies, investment in the form of fixed assets is an important variable to be accounted for. Agricultural cooperative marketing societies rely on fixed assets, such as godowns/warehouses, agricultural machinery, and retail sales centres, to deliver services to the farmers more efficiently. These assets are essential for the procurement of agricultural produce, as well as the storage and distribution of fertilizers, pesticides, and seeds. In fact, all agriculture cooperative marketing societies have created adequate infrastructure to carry out the basic functions of agriculture marketing in the districts. Investments made in the creation of fixed assets over the period, have been enabling DCMS to diversify their business operations and contributing to the generation of additional income to them. The compound annual growth rate for Fixed assets had increased at the rate of 6.68% during 2019-2023. Table 1 provide information on mean and dispersion on Fixed assets for twelve DCMS.

(b). Total Expenses

District cooperative marketing societies employ skilled and unskilled labours for diversity of works. In fact, the seasonality of agriculture operations determines the number of labours and the associated expenses. The larger expenses for cooperative marketing societies are associated with the higher volume of trade. Labour charges and management expenses are important components in the total expenses of DCMS. Total expenses include establishment costs, casual labour for procurement operations, loading and unloading, and transportation. The compound annual growth rate for total expenses increased by 2.44% from 2018-19 to 2022-23.

Contingent expenses

A separate discussion on contingent expenses is needed to highlight the important role it plays in the context of cooperative marketing societies. Contingent expenses were related to logistic arrangement for procurement and sales of agriculture commodities. Contingent expenses would bound to increase on account of transportation costs, and revision in wages for unskilled labour during peak seasons. The compound annual growth rate of contingent expenses had shown high growth at 3.73% compared to establishment expenses at 2.44% during 2018-19 to 2022-23. In comparison to low establishment expenses of Rs.7.46 lakhs, Guntur DCMS had reported Rs.62.95 lakhs for contingent expenses in 2022-23. The contingent expenses were highest for Srikakulam DCMS followed by Guntur DCMS, Nellore DCMS and Kurnool DCMS. For example, Srikakulam DCMS had reported Rs.68.56 lakhs for contingent expenses as much as establishment expenses. Consistently all cooperative marketing societies had incurred high contingent expenses with low variability -coefficient of variations was 72.73%.

(c). Financial Resources

Own resources for DCMS include share capital, statutory and non-statutory reserves. These funds were established over time to address financial requirements and support future business expansion. Significantly, the cooperative marketing societies are not reliant on external financial institutions such as cooperative banks or commercial banks for their business operations. The compound annual growth rate of own fund for the period 2018-19 to 2022-23 was 17.16%. There are significant variations in funds positions of DCMS as can be seen with high coefficient of variations in Table 1. DCMS with large financial resources are expected to have diversified business operations leading to higher net earnings. The coefficient of variations for reserve funds of the cooperative marketing societies was 190.81%. The high coefficient of variation for reserve funds in DCMS is largely due to reserve creation stemming from net profits earned which in turn propelled by diversified business operations of a few large DCMS.

Output Variables

(d). Total earning

Total earnings for cooperative marketing societies come from direct sales of agriculture outputs and

inputs, rental income from godowns and shopping complexes, commissions earned on sales of inputs and outputs, interest income from investments in financial instruments and income earnings from managing retail stores. In 2022-23, the average values of sales of 12 DCMS was Rs.2260.65 lakhs (Table 1). Only three DCMS namely West Godavari DCMS, Guntur DCMS and East Godavari DCMS had exceeded average sales of twelve cooperative marketing societies. As in the case of high coefficient of variations found for procurement, there is high coefficient of variation for sales at 136.37%.

Many DCMS generate rental income from storage space / facilities offered to members, private traders, and from commercial shops leased to private parties. Interest income on fixed deposits in commercial banks and dividend income on financial instruments invested in the banks and marketing federations provide substantial income to the DCMS. Besides, the DCMS at times of festivities generate income from sales of firecrackers. A few cooperative marketing societies opened pharmaceutical stores selling generic medicines.

Table 1. Basic information for DCMS

S. No	Particulars	2018-19	2019-20	2020-21	2021-22	2022-23	CAGR (%)
(1).	Procurement						
	Average	4556.22	4577.98	2166.16	1919.63	2251.06	-13.15
	Std	8446.52	7217.39	2211.25	2390.18	3107.75	
	CV (%)	185.38	157.65	102.08	124.51	138.06	
(2).	Sales						
	Average	4869.94	4577.76	2358.24	2034.00	2260.65	-14.23
	Std	8526.18	7242.62	2496.93	2531.45	3082.85	
	CV (%)	175.08	158.21	105.88	124.46	136.37	
(3).	Miscellaneous Earnings						
	Average	88.19	101.30	166.40	119.84	97.94	2.12
	Std	109.68	172.78	311.13	174.97	164.92	
	CV (%)	124.37	170.57	186.97	146.01	168.39	
(4).	Investment						
	Average	306.64	291.26	415.76	420.27	410.86	6.03
	Std	327.53	333.03	449.73	489.01	425.93	
	CV (%)	106.81	114.34	108.17	116.36	103.67	
(5).	Reserves and other Funds						
	Average	126.72	180.44	217.91	227.21	279.77	17.16
	Std	403.98	441.00	453.29	511.10	533.83	
	CV (%)	318.80	244.40	208.02	224.95	190.81	
(6).	Establishment Expenses						
	Average	42.25	45.30	51.72	48.00	47.65	2.44
	Std	34.38	32.15	43.86	28.64	27.97	
	CV (%)	81.38	70.97	84.79	59.66	58.70	
(7).	Contingent expenses						
	Average	29.19	46.54	44.34	45.23	35.06	3.73
	Std	25.12	64.24	37.67	45.58	25.50	
	CV (%)	86.04	138.05	84.95	100.77	72.73	
(8).	Working Fund						
	Average	764.34	1229.59	1038.58	1031.91	1128.34	8.10
	Std	520.12	983.65	880.58	988.24	1097.88	
	CV (%)	68.05	80.00	84.79	95.77	97.30	
(9).	Fixed Assets						
	Average	151.34	162.77	176.83	209.39	209.06	6.68
	Std	154.25	154.96	160.60	192.68	194.57	
	CV (%)	101.92	95.20	90.83	92.02	93.07	
(10).	No of Profit Making	10	9	9	10	8	
	Total Profit	763.53	1797.65	1023.51	1060.20	591.13	
(11).	No of Loss Making	2	3	3	2	4	
	Total Loss	-129.27	-150.75	-109.28	-116.57	-197.50	

Source: Balance sheets, and profit and Loss Accounts of individual District Cooperative Marketing Societies -2018-19 to2022-23.

Among DCMS, Guntur DCMS had highest miscellaneous income at Rs.610.65 lakhs in 2022-23. Several DCMS had incurred losses primarily due to significant fall in procurement of agriculture outputs and its consequent adverse impact on sales of agriculture commodities. Miscellaneous income provided a strong buffer to many of the cooperative marketing societies to absorb business losses to manage their working capital needs and sustain their business operations.

Potential increase in miscellaneous income

The compound annual growth rate of miscellaneous income was 2.12% during 2018-19 to 2022-23. The coefficient of variations in the miscellaneous income was 168.39% suggesting much variability income earnings from various business operations beyond traditional business operations.

There is enormous potential for an increase in the miscellaneous income for many DCMS in their respective districts in the state of Andhra Pradesh; for instance, Nellore DCMS has vast underutilized land parcels in the prime market centres; Chittoor DCMS can ideally scale up its business operations with effective land utilization in rural areas; Srikakulam DCMS and Kurnool DCMS can raise their business turnovers with their existing fixed resources. Across the cooperative marketing societies, greater diversification of their business activities would strengthen their financial position and gradually reduce their overdependence on traditional procurement and sales of agriculture produces which witnessed intense competitions with the emergence of new crop of entrepreneurs and presence of numerous old players especially private traders in rural areas.

(e). Investments

A few successful cooperative marketing societies have generated surplus funds consistently. These societies had invested surplus funds in various financial instruments, like fixed deposits, National Saving Certificates and in the shares of cooperative marketing federations like IFFCO and KRIBHCO. The compound annual growth rate of investments for the period 2019-2023 was 6.03% per annum. In 2022-23, the average value of investments for twelve district cooperative marketing societies was Rs.410.86 lakhs. Three DCMS namely East Godavari DCMS, Guntur DCMS and Kadapa DCMS exceeded average value of

investment levels of twelve cooperative marketing societies. East Godavari DCMS and Guntur DCMS have invested respectively Rs.1392.48 lakhs and Rs.1035.56 lakhs in 2022-23 in various investment vehicle.

Though Kadapa DCMS had incurred losses in recent years despite significant drops in traditional business operations, its continuity and survival hinged on its past savings as it invested in various financial instruments amounting to Rs.525.84 lakhs in 2022-23. The interest income was a significant source for Kadapa DCMS for meetings their operational expenses. Similar is the case for Ananthapur DCMS.

Kurnool DCMS, Nellore DCMS and Visakhapatnam DCMS had lowest investments among twelve DCMS with less than Rs.100.00 lakhs. Overall, the coefficient of variations for investments by district cooperative marketing societies was 103.67% suggesting much variability in the investment levels of the cooperative marketing societies as it was influenced by past savings

Correlation among inputs and output variables

To obtain reliable efficiency estimates under SBM super efficiency for cooperative marketing societies, it is prerequisite to find interrelationships and the strength of correlations among inputs and outputs. The independent variable, Fixed assets have negative correlation with another independent variable, Total expenses. The value of Fixed assets has low correlation coefficient with third independent variable, Own Funds (financial resources of cooperative marketing societies). In short, correlation coefficients among input variables are low suggesting that these three independent variables are not interdependent and can be used effectively in the DEA SBM super efficiency model. The correlation coefficient of inputs variables with the output variables showed that the value of input variable, Fixed asset has moderate correlation with output variables (a) Total earnings and (b) Investments; the input variable, Total Expenses have negative but moderate correlations with (a) output variable, Total Earnings and (b) have low correlation coefficient with second output variable, Investments. The input variable, Own Funds, exhibits a high correlation with both output variables, (a) Total Earnings and (b) Investment.

Table-2. Description of Variables

S. No	Variables	Description
1	Fixed Assets (X1)	Value of immovable and movable properties such as godowns, farm retails outlets in villages, shopping complexes/centres in district headquarters, farm machinery, office buildings, furniture, fittings, and computers and printers etc
2	Total Expenses (X2)	Management and establishment expenses. Expenses include contingent expenses such as transportation costs, loading and unloading costs relating to procurement and sales of agriculture inputs and outputs.
3	Financial Resources (X3)	Deposits, share capital, and statutory and non-statutory reserves created from the net profits earned over time.
4	Total Earnings (Y1)	Earnings from the sales of agriculture inputs and outputs, from the sales of medicines /pharmaceutical products, and from the seasonal sales of firecrackers, rental income from shopping complex, from godowns, interest income on fixed deposits with banks, dividend income on shares in the apex cooperative marketing federations.
5	Investment (Y2)	Investments in the form of fixed deposits and shares in Apex cooperative marketing federations and NSC certificates and other financial instruments.

VII.METHODOLOGY

Data Envelopment Analysis (DEA)

Technical efficiency analysis provides valuable information for decision makers on the use of inputs to obtain maximum outputs for higher profitability and for sustained growth. With a seminal empirical work on technical efficiency analysis initiated by Michel Farrel (1957), there are vast theoretical and empirical works extending non-parametric methods of mathematical programming technique to measure the efficiency of resource use in production of goods and services. Charnes, Cooper, and Rhodes (1978) expanded Michel Farrel's (1957) non-parametric linear programming technique to handle multiple inputs and outputs, terming it data envelopment analysis. Data envelopment analysis (DEA) involves construction of facets of frontier production surface from given sample units called Decision Making Units (DMUs). DEA envelops best performing data points in the sample and form a production frontier surface. Banker-Charnes-Cooper (1984) extended non-parametric linear programming techniques by incorporating flexible production technology such as constant, increasing and decreasing returns to scale.

Although CCR and BCC models distinguish inefficient DMUs from efficient ones, they do not address the classification and discrimination among efficient firms. Firms may be efficient, but they may not be efficient in the sense of fulfilling the optimal condition of Pareto-Koopman criteria which requires zero input slacks (excess use of inputs) and zero output slacks (output shortfall).

The traditional data envelopment analysis has limitations as it confines technical efficiency scores of firms within the range of zero to one. This restriction creates challenges in classifying and distinguishing among efficient firms. The traditional DEA model assumes proportional radial contraction of inputs or proportional expansion of outputs. Firms are 100% efficient if they are on the production frontier surface. Firms are inefficient if they lie below the production frontier surface. Efficient firms are those which do not have input slacks (excess consumption of inputs) and output slacks (output shortfalls).

Structure of the Model

Let there be N number of firms using M number of inputs, forming an $M \times N$ matrix (X) and producing S number of outputs, forming $S \times N$ matrix (Y). Each DMU_j (j=1, 2, ..., n.) consumes m vector of inputs, (x_1, x_2, \dots, x_m) and each DMU_j produces s vector of outputs, (y_1, y_2, \dots, y_s) . In set form, the production possibility set is defined as:

$$P = \{X, Y \mid x_{ik} \geq X_{ij}, y_{rk} \leq Y_{rj}; X > 0, Y > 0\}$$

x_{ik} denotes i th input used by k th DMU_k under evaluation consuming input vector $(i=1, 2, \dots, m)$, not lesser than its referent set of DMUs inputs X_{ij} , for $i = 1, 2, \dots, m; j = 1, 2, \dots, n.$; y_{rk} denotes r th output produced by k th DMU_k producing vector of outputs under evaluation; $(r=1, 2, \dots, s)$, producing output not higher than its referent set of Y_{ij} , DMUs. It is assumed the input vectors and output vectors are non-negative.

Ranking of Decision-making units

Anderson and Peterson (1993), hereafter A-P model, introduced a method for ranking decision-making units based on efficiency scores among efficient firms, using methodology of Data Envelopment Analysis (DEA) developed by Charnes, Cooper, and Rhodes (CCR, 1978). CCR DEA model assumes constant returns to scale in production function. The advantage of A-P model is that while preserving initial efficiency levels of a DMU under evaluation, a DMU can increase input vector proportionally with reference to efficient firms spanned by whole sample of observations, unit under evaluation itself not being in the reference group of estimations. Given the radial direction of the CCR model, the efficiency score for a DMU under evaluation will exceed unity while preserving the initial efficiency levels of DMU despite an increase in the input vector. DMUs among the efficient firms can be ranked based on efficiency scores. The efficiency score measures the radial distance of a DMU under evaluation to the projected point of DMU in the production possibility frontier formed by efficient firms, excluding DMU under evaluation itself from the reference set. If an evaluated DMU is found far from a virtual DMU, an efficiency score for evaluated DMU will be higher. (Jablonsky, 2012).

Slack Based Measure (SBM) super efficiency (Tone 2002)

Unlike A-P model (1993) which is based on radial contraction of inputs and radial expansion of outputs, the super efficiency of SBM proposed by Tone (2002) is based on non-radial approach. The non-radial nature of SBM super efficiency model is flexible one to incorporate changes in the scale of inputs and outputs without the need for maintaining the initial efficiency level of DMU under evaluation. The non-radial approach to measurement of efficiency considers DMU under evaluation spanned by subsets of efficient DMUs excluding the DMU itself from the subsets. The changes in inputs and output vectors for a DMU under evaluation results in changes in efficiency score of firms and ranking of firms with respect to other DMUs. An estimation of SBM super efficiency proceeds in two stages; at the first stage, the efficiency scores of DMUs are calculated using CCR DEA framework. In the second stage, based on efficiency scores for efficient DMUs, SBM model aims to

minimize input slacks (excess consumption of inputs) or expand output (reduce output shortfall) for a DMU under evaluation. The slack based measure of efficiency model developed by Tone (2002) is presented below:

$$\text{minimize } \rho_k = \frac{1 - \frac{1}{m} \sum_{i=1}^m \frac{s_i^-}{x_{ik}}}{1 + \frac{1}{s} \sum_{r=1}^s \frac{s_r^+}{y_{rk}}} \quad \text{-----(1)}$$

$$\text{Subject to} \quad \sum_{j=1}^n x_{ij} \lambda_j + s_i^- = x_{ik}$$

$$\sum_{j=1}^n y_{rj} \lambda_j - s_r^+ = y_{rk}$$

$$\lambda_j \geq 0, s_i^+ \geq 0, s_i^- \geq 0.$$

j=1,2,....., n.
i = 1, 2, ..., m.
r=1, 2,....., s.

$$\lambda_j \geq 0, s_i^+ \geq 0, s_i^- \geq 0.$$

λ_j are the intensity factors derived from the best performing DMUs in the sample. The intensity factor represents the input utilization or output efficiency of the top-performing Decision-Making Units (DMUs) relative to the DMU being evaluated. Inefficient firms can adopt management strategies based on λ_j values for inputs and outputs improvements; s_i^+ and s_i^- are respectively output slacks (shortfall in output) and input slacks (excess consumption of inputs); ρ_k is the efficiency index which ranges from zero to unity. ρ_k shows the share of inputs vector required by DMU under evaluation to produce the output vector within the reference technology. In the input-oriented model, objective function of the DMU (ρ_k) is to minimize use of inputs given output target.

Objective function in equation (1) is given in fractional form. The fractional programming given above can be transformed into linear form using the method developed by Charnes and Cooper's (1962) for estimating the efficiency index of a firm. The denominator of equation (1) is set equal to unity. With a linearization of the equation, minimization problem under super-efficient SBM becomes.

$$\text{min } \delta = \frac{1}{m} \sum_{j=1}^n \frac{x_j^*}{x_{ik}} \quad \text{-----(2)}$$

$$\text{Subject to}$$

$$\frac{1}{s} \sum_{r=1}^s \frac{y_r^*}{y_{ik}} = 1$$

$$\sum_{\substack{j=1, \\ j \neq k}}^n x_{ij} \lambda_j + s_i^- = x_{ik}$$

$$\sum_{\substack{j=1, \\ j \neq k}}^n y_{rj} \lambda_j - s_r^+ = y_{rk}.$$

$$j = 1, 2, \dots, n.$$

$$i = 1, 2, \dots, m.$$

$$r=1, 2, \dots, s.$$

$$\lambda_j \geq 0, s_i^+ \geq 0, s_i^- \geq 0.$$

Comparative analysis of super efficiency and Slack Based Measure (SBM) of super efficiency scores over time

Table 3 Super Efficiency Estimates for DCMS in Andhra Pradesh (2019 to 2023)

DMUs	2019		2020		2021		2022		2023	
	AP SE	Rank	AP SE	Rank	AP SE	Rank	AP SE	Rank	AP SE	Rank
WGDCMS	1.519962	4	2.215178	3	3.650908	1	2.319485	3	2.993444	1
EGDCDMS	1.12275	5	0.796993	8	0.447283	10	1.275261	5	1.061422	8
GDCMS	2.092054	3	1.074923	7	2.794848	3	2.877851	2	2.714501	2
KriDCMS	5.000491	1	4.797265	1	0.553334	9	0.559378	9	0.433707	9
ChitDCMS	0.8947903	6	1.717639	4	0.88148	8	1.085137	7	2.298248	3
NelIDCMS	0.5609151	9	0.701001	9	1.879932	4	0.443478	10	0.159685	11
VijaDCMS	0.2496648	10	0.570392	10	0.914083	7	1.107363	6	1.16363	7
SrikDCMS	0.1895019	11	0.247071	11	0.180973	12	0.279648	12	0.300585	10
KurDCMS	0.180555	12	0.094194	12	0.273409	11	0.293103	11	0.033438	12

Table 3 and Table 4 present respectively super efficiency scores (Anderson and Peterson 1993) and SBM super efficiency scores (Tone 2002) for five years. It can be seen from Table 3 that super efficiency scores under AP model are consistently higher for every DMU than the SBM super efficiency scores given in Table 4. High super efficiency scores under A-P model are due to an assumption of radial direction of the CCR model and not accounting for inputs and output slacks. We can also observe that super efficiency scores are sensitive to data points. In 2019 and 2020, Krishna DCMS (DMU4) experienced a high business operation, which resulted in a high efficiency score, placing it among the top-ranked DCMS. The super efficiency scores reported (Table 3) are higher than those of SBM super efficiency scores reported (Table 4) for DMU4 for 2019 and 2020 when trade volume was significantly

higher. When the volume of trade had declined in relation to other DMUs, the efficiency scores and consequently its ranking had changed

The average super efficiency score for twelve cooperative marketing societies decreased from 1.4448 in 2019 to 1.3291 in 2023 (Table 3). Similarly, the average SBM super efficiency scores had declined from 1.39804 in 2019 to 1.31010 in 2023 (Table 4). The difference in average efficiency scores between super efficiency and SBM super efficiency models arises from their assumptions; the former assumes radial direction of input-output changes, while the

latter assumes non-radial ones. A decrease in an average efficiency score over the period under both super efficiency and relatively largely under SBM super efficiency model could be attributed to improved performance in resource utilization in DCMS with respect to their peer members. In 2023, the low average technical efficiency score in relation to previous years indicated that Decision Making Units (DMUs) across the cooperative marketing societies had generally minimized input slacks relative to their peer groups while simultaneously reducing output slacks (expansion of output). The performance analysis of an individual DCMS indicates that DMU with the own funds and high business turnover had consistently demonstrated high performance results, achieving 100% efficiency. Under this group, are West Godavari DCMS, East Godavari DCMS, Guntur DCMS and Vijayanagar DCMS. On the contrary Visakhapatnam DCMS, Kadapa DCMS and Anantapur DCMS had seen decrease in their efficiency levels in 2023 over 2019 due to loss of business operation to competitors from private and RBKs during this period.

Table 4 shows that SBM super efficiency scores for five years period: in 2019, seven DMUs had technical efficiency score of unity implying they were 100% efficient in using inputs to obtain outputs, while five DMUs had efficiency scores more than unity indicating they could increase their inputs relative to their referent DMUs maintaining the same level of

outputs. In contrast, in 2023, the number of DMUs with efficiency score of unity came down to four; eight DMUs had efficiency scores more than unity indicating not only a scope for improvements in resource utilization given the same level of outputs but also external environments affecting the performance levels of DMUs and necessitating the need for reconfiguration of inputs and outputs mixes.

Kadapa DCMS (DMU11) had consistent performance in terms of efficiency ranking; it ranked two in all years under SBM super efficiency model (Table 4); but it ranked one and four in 2022 and 2023

respectively under super efficiency model (Table3). Though Guntur DCMS (DMU3) is financially strong and is a large cooperative marketing society, the performance ranking for Guntur DCMS fluctuated over the years. It ranked first in 2021, 2022 and 2023 but ranked third in 2019, and seventh in 2020. Although Krishna DCMS (DMU4) has demonstrated strong financial base, it has experienced fluctuations in its business operations over the study period. It ranked first in the initial two years but declined to 7th position in 2021, 8th position in 2022, and further slide to 9th position in 2023.

Table 4 SBM Super Efficiency Estimates for DCMS in Andhra Pradesh (2019 to 2023)

DMUs	2019		2020		2021		2022		2023	
	Tone SBM	Rank	Tone SBM	Rank	Tone SBM	Rank	Tone SBM	Rank	Tone SBM	Rank
WGDCMS	1.173321	4	1.583767	3	1.883636	3	1.439828	3	1.664481	3
EGDCMS	1.077690	5	1	8	1	6	1.091754	5	1.020474	8
GDCMS	1.805536	3	1.025219	7	2.302135	1	2.459148	1	2.55157	1
KriDCMS	3.769809	1	3.646048	1	1	7	1	8	1	9
ChitDCMS	1	8	1.239213	5	1	8	1.028379	7	1.432749	4
NellDCMS	1	9	1	9	1.321722	4	1	9	1	10
VijaDCMS	1	10	1	10	1	9	1.035788	6	1.054543	7
SrikDCMS	1	11	1	11	1	10	1	10	1	11
KurDCMS	1	12	1	12	1	11	1	11	1	12
VisDCMS	1	6	1.407301	4	1	12	1.156561	4	1.134459	5
KadDCMS	1.950224	2	2.065826	2	2.207772	2	2.237981	2	1.734665	2
AnaDCMS	1	7	1.05738	6	1.101306	5	1	12	1.128357	6
Average	1.3980483		1.41873		1.318048		1.287453		1.310108	

Source- Balance sheets, Trading Accounts and Profit and Loss Accounts for 2018-19 to 2022-23.

Though East Godavari DCMS (DMU2) is one of the financially sound cooperative marketing societies, its efficiency ranking had fallen from fifth position in 2019 to eighth position in 2023. The efficiency ranking for Chittoor DCMS had improved from eighth position in 2019 to fourth position in 2023. Vijayanagaram DCMS has improved its efficiency ranking from tenth position in 2019 to seventh position in 2023.

Some DCMS have continued to underperform throughout the study period. Kurnool DCMS (DMU9) has been at the bottom of the efficiency ranking at twelve in 2019 and in 2023 underscoring strong management efforts and business development planning for resource management in the context of a large potential for growth in the region. Srikakulam DCMS (DMU8) with its large resources base and high potential for diversification of business opportunities was ranked eleventh in 2019 and 2023. A sign of efficiency improvement can be seen for

Visakhapatnam DCMS, despite its limited financial resources; it has improved its ranking from sixth place in 2019 to fifth place in 2023.

Comparative analysis of super efficiency and SBM super efficiency projected inputs and output slacks
(a). Super Efficiency estimates – Projected inputs and outputs slacks

Table 5 present comparison of CCR efficiency scores and super-efficiency scores along with ranking of DMUs, input slacks (excess use of inputs) and output slacks (output shortfall) for twelve DCMS in Andhra Pradesh for 2023. Super efficiency scores are larger than the efficiency scores obtained under basic CCR DEA model. In 2023, under CCR model, only four DMUs were 100% efficient: DMU1, DMU2, DMU3, and DMU7. However, under alternative efficiency method, i.e., the super efficiency of the A-P model, their efficiency rankings are determined respectively

1, 8, 2, and 7. To this extent, A-P model discriminates the efficient DMUs and rank them.

In A-P model, DMU1 (West Godavari DCMS) has super-efficiency score of 2.99344 followed by DMU3 (Guntur DCMS) with efficiency score of 2.71460. DMU1 is ranked first despite the presence of

large input slacks for Fixed Assets and Own Funds. DMU3 (Guntur DCMS) ranks second among 12 DCMS, despite having relatively negligible input or output slacks. Further, DMU3 is a peer leader among 12 DCMS and appears as a referent unit for 6 DMUs.

Table 5 Super Efficiency (A-P) Model – Projected Inputs and Outputs (Slacks)

DMU	CCR Model	AP -Super efficiency	Rank	Projected points (Input slacks)			Projected points (Output Slacks)	
				Fixed Assets	Total Expenditure	Own Funds	Total Earnings	Investment
DMU1	1.00000000	2.9934444	1	1220.084	0	1939.57	0	1081.436
DMU2	1.00000000	1.0614224	8	177.5466	0	1223.6351	7075.821	0
DMU3	1.00000000	2.7146013	2	0	0	1.86E-08	0	0
DMU4	0.17951796	0.4337068	9	118.5162	0	0	0	0
DMU5	0.75762511	2.2982478	3	0	90.5085	153.3654	694.4993	0
DMU6	0.22551240	0.1596847	11	0	13.36209	0	0	1.924977
DMU7	1.00000000	1.1636301	7	0	66.41111	933.19599	0	176.1719
DMU8	0.33005884	0.3005845	10	0	0	0	1012.356	0
DMU9	0.13434446	0.0334382	12	3.467481	0	0	0	4.822987
DMU10	0.34523182	1.2143082	6	0	8.02868	0	119.1044	0
DMU11	0.04119958	2.1911924	4	993.5271	0	0	2143.663	0
DMU12	0.27147798	1.3850718	5	50.80104	57.78095	0	0	58.3043

Source- Balance sheets, Trading Accounts and Profit and Loss Accounts for 2022-23

The super efficiency score for West Godavari DCMS (DMU1) was derived as the largest ratio of the virtual inputs to the inputs of the actual firm. Due to radial direction of model, the virtual DMU on the frontier lies far from the actual DMU and hence super-efficiency score was found to larger for the DMU1. The larger projection values correspond with the large super-efficiency scores. It suggests that evaluated DMU1 is efficient even though there is presence of large slacks for DMU1 leading to identification of DMU as super-efficient.

(b). SBM -Super efficiency scores–Projected inputs and output slacks

It is important to note that super efficiency estimates are sensitive to the data points of the decision-making units under data envelopment analysis. An absolute advantage in certain inputs or greater productivity gains in some outputs does not necessarily ensure higher efficiency for those decision-making units. High efficiency depends on effective combination of inputs to produce outputs compared to other decision-making units in the sample. This is illustrated in the following paragraphs.

The SBM -super efficiency score for DMU1 is 1.664481 (Table 6) as against the super-efficiency score of 2.9934440 (Table 5) for the same DMU1 under A-P model. The super efficiency score was reduced by 79.84% $[(2.9934440-1.664481)/1.664481]$. We can see the changes in the ranking based on efficiency scores for twelve DMUs under super efficiency and SBM-super efficiency models. Change in the ranking of DCMS is due to radial direction of (CCR A-P model) and non-radial direction of (SBM models) and in the treatment of inputs and output slacks. For example, the decrease in input slacks in Fixed Assets and Own Funds under the SBM -super efficiency model for DMU3 (Guntur DCMS), which was previously ranked second in the CCR A-P model, ranked first under SBM super efficiency model. Clearly, DMU3 showed zero inputs and outputs slacks. DMU3's SBM-super efficiency score was 2.551570, while the AP super efficiency score was 2.7146013.

In 2023, the average value of the reserves (own funds) of twelve DCMS was Rs.279.77 lakhs. East Godavari DCMS (DMU2) had highest own fund exceeding mean values of the twelve DCMS, but its ranking was

8th among DCMS under A-P model and SBM super efficiency models; it has large input slacks in Fixed assets and Own funds as well as large, short fall in Total Earnings. Despite better resource position, DMU2 could not utilize the resources efficiently. It showed that mere possession of large resources would not guarantee high technical efficiency. Visakhapatnam DCMS (DMU10) with low own fund of Rs.21.18 lakhs was ranked 6th under A-P model and 5th under SBM super efficiency model.

The average value of establishment expenses of twelve DCMS was Rs.47.65 lakhs in 2023. Seven DCMS out of 12 DCMS showed lower than average value of establishment expenses in 2022-23. DCMS which had registered lower than average values of establishment expenses are Guntur DCMS (ranked first), Visakhapatnam DCMS 6th and 5th respectively under A-P and SBM models. Despite the lower-than-average establishment expenditures, the following DCMS have showed varying levels of ranking under SBM super efficiency: West Godavari DCMS (3rdrank), Krishna DCMS (9thrank), Vijayanagar

DCMS (7thrank), Nellore DCMS (10thrank), and Chittoor DCMS (4thrank). Guntur DCMS has lowest establishment expenses at Rs.7.46 lakhs in 2022-23 compared to previous years, despite the fact it registered significant volume of sales in 2022-23. East Godavari DCMS has reported highest establishment expenses at Rs.89.20 lakhs (8thrank) followed by Ananthapur DCMS (6thrank) in 2022-23 (see Table 4). These DCMS are managing supermarkets with help of regular employees leading to higher establishment expenses.

Comparing the super efficiency estimates for A-P model given in Table 5 and SBM super efficiency estimates of Tone (2002) given in Table 6, one can find that many DMUs have reduced their input slacks and output slacks under SBM super efficiency model. Consequently, the ranking of DMUs under A-P model and super efficiency of SBM are altered. In the SBM super efficiency model, Guntur DCMS as expected was ranked first among the twelve district cooperative marketing societies in the state of Andhra Pradesh.

Table 6 Slack Based Measure (SBM) super efficiency model-Projected inputs and outputs slacks

DMU	CCR Model	SBM - Super efficiency	Rank	Projected Point (Input Slacks)			Projected point (Output Slacks)	
				Fixed Assets	Total Expenditure	Funds	Total Earnings	Investment
DMU1	1.00000000	1.664481	3	292.027400	0.000000	161.882200	0.000000	1081.44
DMU2	1.00000000	1.020474	8	157.038100	0.000000	1109.779000	7075.821000	0.00
DMU3	1.00000000	2.551570	1	0.000000	0.000000	0.000000	0.000000	0.00
DMU4	0.17951796	1.000000	9	401.266800	16.947180	0.000000	0.000000	0.00
DMU5	0.75762511	1.432749	4	143.529600	33.431880	19.985220	694.499300	0.00
DMU6	0.22551240	1.000000	10	0.000000	96.071960	135.945800	0.000000	0.00
DMU7	1.00000000	1.054543	7	0.000000	54.324920	780.383100	0.000000	176.17
DMU8	0.33005884	1.000000	11	78.610590	112.836600	74.861530	0.000000	0.00
DMU9	0.13434446	1.000000	12	212.240500	137.897900	272.174000	0.000000	0.00
DMU10	0.34523182	1.134459	5	0.000000	9.082885	0.000000	149.725200	0.00
DMU11	0.04119958	1.734665	2	421.888500	0.000000	0.000000	3163.384000	0.00
DMU12	0.27147798	1.128357	6	19.102940	10.289780	0.000000	0.000000	58.30

Source: Balance sheets, Trading Account and Profit and Loss Accounts for 2022-23

Table 6 provide information on inputs and outputs slacks for twelve DCMS computed under SBM super efficiency model. Under Slack Based Measure super efficiency, Guntur (DMU3) was ranked first with SBM efficiency score of 2.551570. However, under the A-P super efficiency model, Guntur DCMS (Table 5) achieved second place due to the presence of an

input slack value for the variable Own fund, despite its insignificance. Under CCR model, it was efficient with efficiency score of unity.

Kadapa DCMS (DMU11) is ranked second under SBM super efficiency model (it was ranked fourth under A-P model) among 12 district cooperative marketing societies. Kadapa DCMS has large input

slacks for Fixed assets which implied a creation of excess capacity, and which was not fully utilized. Input slacks and output slacks were found under both A-P model and SBM super efficiency model. While input slack (input excess consumption) for Fixed asset had declined from Rs.993.5271 lakhs under A-P model to Rs. 421.8885lakhs under SBM super efficiency estimates, the output slack for Total earnings (output shortfall) had shown a large increase from Rs.2143.66 lakhs under A-P model to Rs.3163.384 lakh under SBM model. Output shortfalls for Total earnings for Kadapa DCMS is very significant. The result is not surprising given the fact that Kadapa DCMS had registered large decline in the procurement and sales of agriculture commodities in recent years contributing to shortfall in Total earnings. At the same time, for Kadapa DCMS, there was neither an input slack for Total expenditure nor an excess consumption of Own Fund; Kadapa DCMS had no output shortfall for second output variable, Investment. Within the referent groups, Kadapa DCMS demonstrated high technical efficiency, which did not necessarily result in high profitability. Kadapa DCMS has been incurring continuous losses in the last three years. The referent subsets for Kadapa DCMS are DMU3 and DMU10. One can see that DMU10 has larger lambda weight than DMU3 signifying its dominance in the subsets for

efficiency benchmarking. Kadapa DCMS can adopt management practices like DMU10 in controlling inputs and producing outputs for further improvement inefficiency scores. Likewise, Visakhapatnam DCMS experienced a smaller output shortfall in Total earnings compared to significant output shortfall observed for the same variable for Kadapa DCMS.

VIII.INPUTS AND OUTPUT TARGETS AND REFERENT DMUS

The input targets and output targets for each DMU along with reference set for each DMU is provided in Table 7. The reference set show the similar DMUs in input and output combinations corresponding to each evaluated DMU. Reference set, based on SBM super-efficiency model provide best λ_j weight for each evaluated DMU. In the reference sets, DMU1, DMU2, and DMU3 appear prominently as benchmarks for inefficient DMUs for emulation of management practices for better performance results. Table 6 also show information on comparison of inputs and output targets. One can notice that DMU3 (Guntur DCMS), though ranked one, has reference DMUs (DMU1 and DMU2); Guntur DCMS under evaluation itself is excluded from the reference set.

Table7: SBM Super efficiency for inputs and output Targets and Reference sets for 2023

DMU	Input Targets			Output Targets		Reference sets
	Fixed Assets	Total expenditure	Funds	Total Earnings	Investment	Referent (Lambda)
DMU1	173.52713	92.89633	729.88463	9937.4265	1366.279	D3(1.319363)
DMU2	176.85517	94.67797	743.88296	10128.015	1392.483	D3(1.345)
DMU3	472.76861	73.56045	1668.15403	7531.99	1035.56	D1(0.56503), D2 (0.62810)
DMU4	95.9218	59.64064	295.45741	1659.8899	297.8368	D1(0.07658), D2(0.09945), D10(2.02143)
DMU5	19.67428	10.53246	82.75336	1126.6924	154.9069	D3(0.15)
DMU6	23.814815	4.606682	23.966252	221.27578	26.40214	D1(0.02013), D5(0.03759), D11(0.02823)
DMU7	36.49625	19.53797	153.50945	2090.0411	287.3561	D3(0.277)
DMU8	111.18287	23.82621	510.67724	1374.0376	359.3828	D1(0.06295), D2(0.24521)
DMU9	18.881875	2.477182	14.314671	142.833	17.0000	D1(0.01393), D11(0.02478)
DMU10	13.38766	14.85712	29.72355	444.2252	68.04	D3(0.04107), D12(0.09702)
DMU11	78.27522	82.51177	244.18671	3339.4658	525.8356	D3(0.34871), D10(2.42102)
DMU12	63.21442	113.04091	100.00862	1390.5826	321.2742	D10(4.722)

Source- Balance sheets, Trading Account and Profit and Loss Accounts for 2022-23

Summary and Conclusions

This study has utilized the super efficiency model developed by Anderson and Peterson (1993) and slack based measure (SBM) super efficiency advanced by

Tone (2003) for ranking the technical efficiency levels of twelve district cooperative marketing societies in the state of Andhra Pradesh. The technical efficiency analysis was conducted for 2018-19 to 2022-23. The average super efficiency score for twelve cooperative

marketing societies decreased from 1.4448 in 2019 to 1.3291 in 2023. The average SBM super efficiency scores had declined from 1.39804 in 2019 to 1.31010 in 2023. The difference in average efficiency scores between super efficiency and SBM super efficiency models arises from their model assumptions; the former assumes radial direction of input-output changes, while the latter assumes non-radial ones. A decrease in an average efficiency score over the period under

both super efficiency and relatively large reduction under SBM super efficiency model could be attributed to improved performance in resource utilization in DCMS with respect to their peer members. The decline in the average efficiency of cooperative marketing societies can also be attributed to government's withdrawal of patronage extended to the cooperative marketing societies regarding procurement and sales of agriculture commodities and consequent fall in the business operations in the last three years and its levelling off the large disparities that existed among cooperative marketing societies. The estimates and their ranking of cooperative marketing societies are found to be sensitive due to treatments of inputs and outputs slacks under A-P and SBM models. The average score of three DCMS namely Gunter DCMS, West Godavari DCMS, and East Godavari DCMS are identified as best performing cooperatives; they have reported high business turnover and large earnings emanating from diversified business operations; self-reliance due to own funds in the form of reserves funds; judicious planning and investments in financial instruments; control in management costs; and all these factors contributed to their continuous profits and sustained growth. The DEA efficiency estimates nevertheless are sensitive to the data points. An absolute advantage in certain inputs or greater productivity gains in some outputs does not necessarily ensure higher efficiency for those decision-making units. It is the effective combination of all inputs in producing outputs in relation to referent decision making units in the sample that yield higher efficiency scores. This is highlighted sharply for West Godavari, Guntur DCMS, and East Godavari DCMS, which possessed robust financial resources; however, their rankings varied due to the presence of output inefficiencies.

District cooperative marketing societies can enhance their efficiency levels by intensively using fixed assets, effectively utilizing own funds for business diversification and finding profitable investments avenues and adopting modern management practices. The Guntur district cooperative marketing society sets high performance benchmarks for other cooperative marketing societies in the state for diversified business practices and the advantage of maintaining institutional networks.

The Kurnool, Nellore, Anantapur Visakhapatnam DCMS can be turned into a viable organization in the medium- terms to long- terms with effective use of existing resources especially fixed assets as they are operating in prime market centres. Ananthapur DCMS operate in the adverse natural environment with less natural resources; other DCMS are operating in commercially progressive districts with rising per capita income, and with availability of abundant skilled and unskilled labour and scope for diversified business undertakings.

Weak cooperative marketing societies struggle not due to a lack of funds, but because DCMS are risk-averse and hesitant to take on new business ventures. The performance analysis of cooperative marketing societies shows significant potential for agro-processing units in the respective districts. DCMS, with their long and extensive rural networks shall establish and manage agro-processing units and offer value-added services to farmers for sustained growth.

General Recommendations for DCMS

Though District Cooperative Marketing Societies have PACS as primary members, all DCMS could not effectively leverage their advantage of their social networks for rising their business turnover nor utilized their social capital for procuring agriculture outputs from farmers. The strong revival of old business practices with modern management tools is needed for their sustained growth. The recent institutional arrangement between the Andhra Pradesh Marketing Federation and PACS, bypassing DCMS which previously served as a major partner and nodal agency for the distribution of agricultural inputs and the procurement of agricultural outputs, has negatively impacted the volume of business operations for marketing societies. The competitions and rivalries

among cooperatives may be avoided for their mutual economic interests. To make DCMS more effective and efficient in delivery of services towards farmers at the ground level, the Andhra Pradesh Market Federation must restrict itself to major such as supervision and control at the state level on the distribution of inputs and procurement of outputs.

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