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A Stochastic Study on Different Oil Seeds Using DEA Approach

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Abstract-This paper contains a number of to measure technical efficiency of Decision Making Units (DMU's)**.** This approach engages the linear programming technique (L.P.P) with parametric and non-parametric production frontiers in easy way. The parametric estimates cannot be subjected to significance tests due to the non-obtainability of standard errors (S.E's).

In this Paper we proposed a method of stochastic production frontiers- technical efficiency of Cobb-Douglas frontier production function as a linear programming problem (L.P.P).This method can be stretched in easy way to any parametric frontier production or cost function which is linear in parameters.

Keywords: DEA, DMUs, Peer, Technical Efficiency, Super Efficiency.

I. INTRODUCTION

Efficiency is critical for organizations that seek to be both environmentally conscious and profitable. Efficiency has implications for a "win-win" situation to arise. Studying and managing organizations from this perspective requires an evaluation of efficiency. To aid researchers and managers develop measures for efficiency we review the use of data envelopment analysis (DEA) for this purpose. DEA theory and application has increased greatly. Its use as a tool for environmental performance evaluation has been limited. In this paper we provide a method of stochastic production frontiers- technical efficiencyof Cobb-Douglas frontier production function as a linear programming problem (L.P.P).

II. EFFICIENCY MEASUREMEN CONCEPT

The primary purpose of this section is to outline a number of commonly used efficiency measures and to discuss how they may be calculated relative to an efficient technology, which is generally represented by some form of frontier function. Frontiers have been estimated using many different methods over the past 40 years.

The two principal methods are:
1) Data envelopment analysis (DEA) and
2) Stochastic frontiers analysis (SFA),
Which involve mathematical programming and econometric methods, respectively. This paper is concerned with the use of DEA methods. The discussion in this section provides a very brief introduction to modern efficiency measurement. A more detailed provided by Fare, Grosskopf and Lovell and Lovell. Modern efficiency measurement begins with Farrell who drew upon the work of Debreu and Koopmans to define a simple measure of firm efficiency, which could account for multiple inputs. He proposed that the efficiency of a firm consists of two components: technical efficiency, which reflects the ability of a firm to obtain maximal output from a given set of inputs, and allocative efficiency, which reflects the ability of a firm to use the inputs in optimal proportions, given their respective prices. These two measures are then combined to provide a measure of total economic efficiency.

Super efficiency computations may result in infeasibility and the computations are linear programming based. It can be shown that for all DMUs which represent extreme point of the frontier production function, the input oriented super efficiency either larger then unity or the super efficiency problem is infeasible. For any DMU which is either weakly efficient or efficient but does not represent an extreme point, super efficiency score can be shown equal to unity. Therefore, for such DMUs unit input super efficiency score implies no additional input gains. To measure the performance of the states, we ranked using the AP ranking method using VRTS environment.

DATA

The secondary data are collected from The Directorate of Economic and Statistics in the Ministry of Agriculture, Govt. of India covering the period 2013-2014. The variables chosen for this study are, Input Variables: **Area** and **Production** and Output Variable: **Yield**

A METHOD OF STOCHASTIC PRODUCTION FRONTIERS- TECHNICAL EFFICIENCY:

The production function model may be written as,

$$y_i = f\left(x_i, \beta\right) + \varepsilon_i \qquad i = 1,2,3,.......n \qquad \text{.... (1)}$$

Where y_i is output

x_i is input vector

β is vector of parameters

ε_i is disturbance term

$\Rightarrow \varepsilon_i = v_i - u_i$, Here $v_i \sim N\left(0, \sigma_v^2\right)$

u_i is one sided disturbance term that follows half normal distribution with mean zero and variance σ_u^2

$$E(\varepsilon_i) = -E(u_i)$$

$$\sigma^2 = V(\varepsilon_i) = \sigma_u^2 + \sigma_v^2$$

Let $$g(u,v) = \frac{1}{\pi\sigma_u\sigma_v}\exp\left[\frac{-u^2}{2\sigma_u^2} - \frac{v^2}{2\sigma_v^2}\right] u \geq 0 \qquad \text{.....(2)}$$

$$g_1(u) = \sqrt{\frac{2}{\pi}}\frac{1}{\sigma_u}\exp\left[-\frac{u^2}{2}\right], \qquad 0 < u < \infty$$

$$g_2(v) = \frac{1}{\sqrt{2\pi}\sigma_v}\exp\left[-\frac{v^2}{2}\right], \qquad -\infty < v < \infty$$

$$g(u,v) = g_1(u) g_2(v)$$

Define $\varepsilon = v - u$. The joint distribution of u and ε takes the form,

$$g(u,v) = \frac{1}{\pi\sigma_u\sigma_v}\exp\left[\frac{-u^2}{2\sigma_u^2} - \frac{(\varepsilon+u)^2}{2\sigma_v^2}\right] \qquad \text{..... (3)}$$

$$= \frac{1}{\pi\sigma_u\sigma_v}\exp\left[\frac{-u^2}{2\sigma_u^2} - \frac{(\varepsilon^2 + u^2 + 2\varepsilon u)}{2\sigma_v^2}\right]$$

The marginal distribution of ε is,

$$\int_{-\varepsilon}^{\infty} g(u,\varepsilon)du = \sqrt{\frac{2}{\pi}}\frac{1}{\sigma}(1-F)\exp\left[\frac{\varepsilon^2}{2\sigma^2}\right]$$

where $-\varepsilon \geq 0$, $\sigma^2 = \sigma_u^2 + \sigma_v^2$

$$1 - F = 1 - F\left(\frac{\varepsilon\lambda}{\sigma}\right), \qquad \text{where} \lambda = \frac{\sigma_u}{\sigma_v}$$

$$g_2(\varepsilon) = \sqrt{\frac{2}{\pi}}\frac{1}{\sigma}(1-F)\exp\left[-\frac{\varepsilon^2}{2\sigma^2}\right]$$

$$g(u,\varepsilon) = g_1(u/\varepsilon) g_2(\varepsilon)$$

$$g_1(u/\varepsilon) = \frac{g(u,\varepsilon)}{g_2(\varepsilon)}$$

$$g_1(u/\varepsilon) = \frac{1}{1-F}\frac{1}{\sqrt{2\pi\sigma_*^2}}\exp\left[-\frac{\left(u+\sigma_u^2\frac{\varepsilon}{\sigma^2}\right)^2}{2\sigma_*^2}\right] \quad \text{….. (4)}$$

Where $\sigma_*^2 = \frac{\sigma_u^2\sigma_v^2}{\sigma^2}$

F is evaluated at $\frac{\varepsilon\lambda}{\sigma} = -\frac{\mu_*}{\sigma_*}$

$$\mu_* = \frac{-\sigma_u^2\varepsilon}{\sigma^2}$$

$$g_1(u/\varepsilon) = \frac{1}{1-F}\frac{1}{\sqrt{2\pi\sigma_*^2}}\exp\left[-\frac{(u-\mu_*)^2}{2\sigma_*^2}\right], \quad u \geq 0 \quad \text{….. (5)}$$

$$\varepsilon = v - u$$

$$f(u,v) = \frac{1}{\sigma_u}e^{-\frac{u}{\sigma_u}}\frac{1}{\sqrt{2\pi}\sigma_v}e^{-\frac{v^2}{2\sigma_v^2}} \quad \text{….. (6)}$$

In a similar way we obtain,

$$\mathrm{E}(u/\varepsilon) = \sigma_v\left[\frac{f(z)}{1-F(z)} - z\right] \quad \text{…. (7)}$$

where $z = \frac{\varepsilon}{\sigma_v} + \frac{\sigma_v}{\sigma_u}$

The mode of the conditional distribution of u is,

$$M(u/\varepsilon) = \begin{cases} -\varepsilon - \frac{\sigma_v^2}{\sigma_u}, & \text{if } \varepsilon \leq -\frac{\sigma_v^2}{\sigma_u} \\ 0, & \text{if } \varepsilon > -\frac{\sigma_v^2}{\sigma_u} \end{cases} \quad \text{…. (8)}$$

III. IMPIRICAL INVESTGATION IN NINE OIL SEEDS PRODUCTION

1. **Nine Oil Seeds Production Efficiencies:**

Table: 1.1.

S.NO	STATES/UT	CRSTE	VRSTE	SCALE
1	Gujarath	0.026	0.125	0.211drs
2	Madhyapradesh	0.007	0.011	0.620irs
3	Rajasthan	0.010	0.012	0.838irs
4	Maharashtra	0.011	0.013	0.858irs
5	Andhrapradesh	0.026	0.038	0.681irs
6	Karnataka	0.034	0.055	0.622irs
7	Tamilnadu	0.207	1.000	0.207drs
8	Westbengal	0.065	0.075	0.864irs
9	Uttar pradesh	0.046	0.075	0.614irs
10	Haryana	0.108	0.342	0.316drs
11	Assam	0.182	0.437	0.416irs

12	Odisha	0.232	0 .437	0.530irs
13	Bihar	0.406	0.500	0.812irs
14	Punjab	1.000	1.000	1.000 -

The 14 states of India play a major role and have an impact on **nine oil seeds** are considered to be the decision making units. Each state is assumed to combine two inputs to produce a single output. The distribution of efficiencies under constant and variable returns to scale and scale efficiencies are given below:

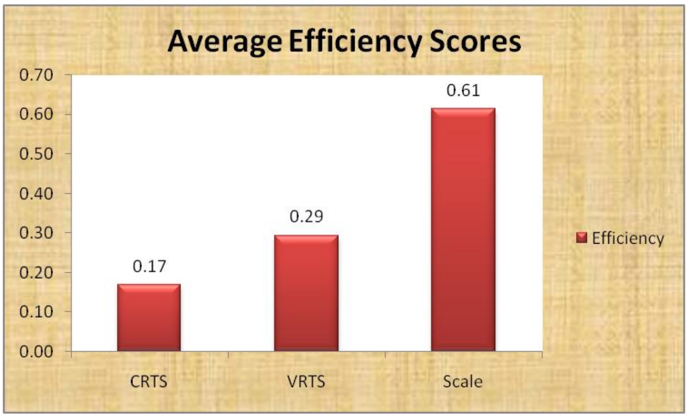

Fig: 1.1

Overall, the states experienced 83% of input losses in CRTs and 71% in VRTS environment respectively. Due to scale inefficiency the states experienced only 39% of input losses for this agricultural production.

2. Peers and Ranking of DMUs and Super Efficiency:

Table: 1.2.

S.NO	States / UT	Peers	Peer Count	Peer Weight	Super Efficiency	Rank
1	Gujarath	14, 7	0	0.158, 0.842	0.1247	7
2	Madhyapradesh	14	0	1.000	0.0105	14
3	Rajasthan	14	0	1.000	0.0115	13
4	Maharashtra	14	0	1.000	0.0134	12
5	Andhrapradesh	14	0	1.000	0.0380	11
6	Karnataka	14	0	1.000	0.0547	10
7	Tamilnadu	7	2	1.000	Big	1
8	Westbengal	14	0	1.000	0.0755	8
9	Uttar pradesh	14	0	1.000	0.0753	9
10	Haryana	7, 14	0	0.255, 0.745	0.3417	6
11	Assam	14	0	1.000	0.4375	5
12	Odisha	14	0	1.000	0.4376	4
13	Bihar	14	0	1.000	0.5000	3
14	Punjab	14	12	1.000	4.4998	2

Here the State with largest peer count is considered to be a most popular role model State in agricultural production. In the analysis it has been observed that the **Punjab** appeared as an efficient peer state in the peer list of 12 inefficient States in agricultural Production. **Tamil Nadu** appeared as an efficient peer of 2 inefficient states in agricultural production

3. Nine Oil Seeds Production State by State Analysis:

Table: 1.3.

States	Variable	Original value	Radial movement	Slack movement	Projected value	TE
Gujarath	Yield	2222	0	0	2222	0.125
	Area	3.08	-2.696	-0.023	0.361	
	Production	6.84	-5.987	0	0.853	
Madhya Pradesh	Yield	850	0	522	1372	0.011
	Area	7.83	-7.748	-0.032	0.05	
	Production	6.66	-6.59	0	0.07	
Rajastan	Yield	1150	0	322	1372	0.012
	Area	5.28	-5.219	-0.011	0.05	
	Production	6.07	-6	0	0.07	
Maharastra	Yield	1177	0	195	1372	0.013
	Area	4.45	-4.391	-0.009	0.05	
	Production	5.24	-5.17	0	0.07	
Andhra Pradesh	Yield	934	0	438	1372	0.038
	Area	1.97	-1.895	-0.025	0.05	
	Production	1.84	-1.77	0	0.07	
Karnataka	Yield	853	0	519	1372	0.055
	Area	1.51	-1.427	-0.033	0.05	
	Production	1.28	-1.21	0	0.07	
Tamil Nadu	Yield	2382	0	0	2382	1
	Area	0.42	0	0	0.42	
	Production	1	0	0	1	
West Bengal	Yield	1186	0	186	1372	0.075
	Area	0.79	-0.731	-0.009	0.05	
	Production	0.93	-0.86	0	0.07	
Uttar Pradesh	Yield	842	0	530	1372	0.075
	Area	1.11	-1.026	-0.034	0.05	
	Production	0.93	-0.86	0	0.07	
Haryana	Yield	1630	0	0	1630	0.342
	Area	0.55	-0.362	-0.043	0.145	
	Production	0.9	-0.592	0	0.308	
Assam	Yield	571	0	801	1372	0.437
	Area	0.28	-0.158	-0.072	0.05	
	Production	0.16	-0.09	0	0.07	
Odisha	Yield	727	0	645	1372	0.437
	Area	0.22	-0.124	-0.046	0.05	
	Production	0.16	-0.09	0	0.07	
Bihar	Yield	1114	0	258	1372	0.5
	Area	0.13	-0.065	-0.015	0.05	
	Production	0.14	-0.07	0	0.07	
Punjab	Yield	1372	0	0	1372	1
	Area	0.05	0	0	0.05	
	Production	0.07	0	0	0.07	

To measure the performance of the states, we ranked using the AP ranking method using VRTS environment. The **Tamil Nadu** state seems to be the best state in producing the output with the available input units and next **Punjab** producing more output comparing to other states. The following diagram explains the movement of the states performance in different environments.

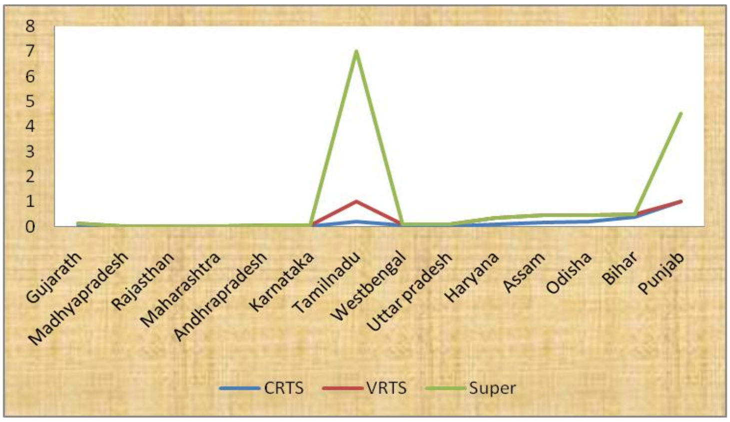

Fig: 1.2.

IV. CONCLUSION

In this paper we analysed here the state with largest peer count is considered to be a most popular role model state in agriculture production. In the analysis, it has been observed that the Punjab appeared as an efficient peer state in the peer list of 12 inefficient States in agricultural Production in nine oil seedsTamil Nadu appeared as an efficient peer of 2 inefficient states in agricultural production in nine oil seeds. We ranked the rest of the DMUs based on their super efficiency. The top most and the bottom most Agricultural states are Tamil Nadu and Madhya Pradesh respectively.

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