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Efficiency of Agricultural Production (Rice & Wheat) By Using Data Envelopement Analysis

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Abstract: *Data Envelopment Analysis(DEA) is a method based upon an interesting application of linear programming technique. It was only developed for performance measurement. It has been employed for assessing the relative performance of a set of firms that uses a variety of identical inputs to produce a variety of identical outputs. The main aim of the present research study is to measure the efficiency of the Indian agricultural production by using the data envelopment analysis.*
Key Words: *DEA, DMU, VRSTE, CRSTE, Production*

I. Introduction

Data Envelopment Analysis(DEA) is a linear-programming based technique for measuring the performance efficiency of organizational units, which are termed as Decision-Making Units (DMU). This technique aims to measure how efficiently a Decision-Making Unit uses the resources available to generate a set of outputs. This method has been successfully employed for assessing the relative performance of set of firms that uses a variety of identical inputs to produce a variety of identical outputs.

Data Envelopment Analysis(DEA) is a methodology based upon an interesting application of linear programming. It was originally developed for performance measurement. It has been employed for assessing the relative performance of a set of firms that uses a variety of identical inputs to produce a variety of identical outputs. DEA involves the use of linear programming methods to construct a non-parametric surface (or frontier) over the data, so as to be able to calculate efficiencies relative to this surface. The rudiments DEA are due to Farrell (1957).

The modern efficiency measurement begins with Farrell (1957) who drew upon the work of Debreu (1951) and Koopmans (1951) to define a simple measure of firms efficiency which could account for multiple inputs. He proposed that the efficiency of a firm consists of two components .

(i) Technical Efficiency (TE), which reflects the ability of a firm to obtain maximum output from a given set of inputs, and (ii) Allocative Efficiency (AE), 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.

I. Stochastic Frontier Cost Function Using Maximum Likelihood Estimation:

Schmidt and Lovell (1977) have investigated for the relationship among the stochastic production, factor demand and cost frontier. They have demonstrated how an inefficient production process can be modelled in an empirically useful way by using these frontiers.

Under the assumption that the firm seeks to minimize the cost of producing its desired rate of output subject to stochastic production constraint, the firm's production technology is characterized by a production function of the firm.

Let $y = a \prod_{i=1}^{n} x_i^{\alpha_i} e^{\in}$ … (2.1)

Where y is output, and x_i is are inputs of production process to be estimated. The disturbance term is assumed to be of the form $\in = v + u$. Here v is distributed as $N(0, \sigma^2)$ and captures random variation in output due to factors outside the control of the firm. On the other-hand, 'u' is a non-positive disturbance, reflecting the technical inefficiency.

The equation (2.1) in log linear form can be written as:

$$\ln y = A + \sum_{i=1}^{n} \alpha_i \ln x_i + (v + u) \qquad (2.2)$$

Where A = ln a, ln y is bounded from above by the stochastic production frontier $A + \sum_{i=1}^{n} \alpha_i \ln x_i + v$ with technical efficiency relative to the frontier given by 'u' percent. The cost function derived is of the form:

$$\ln C = K + (1/r) \ln y - \sum_{i=1}^{n} (\alpha_i / r) \ln p_i - (1/r)(v - u) \qquad (2.3)$$

where $K = \ln \left(\sum_{i=1}^{n} k_i \right)$

Here ln C bounded from below by the stochastic cost frontier, and

$$K + (1/r) \ln y - \sum_{i=1}^{n} (\alpha_i / r) \ln p_i - (1/r) v$$

represents the minimum possible cost of producing output y and prices p_i. The cost frontier is stochastic. The term (1/r) u in equation (2.3) represents the percent by which actual cost exceeds the cost frontier. In other words, it measures the extra cost of producing below the production frontiers, that it technically inefficient. The cost function is linearly homogeneous in input prices, they rewrite it as:

$$\ln (C / P_n) = K - (1/r) \ln y + \sum_{i=1}^{n-1} (\alpha_i / r) \ln (P_i / P_n) - (1/r)(v - u) \qquad (2.4)$$

For estimation of equation (2.3) we applicable Ordinary least square (OLS) procedure on the cost function as given in (2.4). This gives consistent estimates of the parameter r, (α_1 / r), (α_2 / r), …., (α_{n-1} / r). From these, we can obtain consistent estimates of r, α_1, α_2, …., α_n.

EMPIRICAL INVESTGATION:

Rice production:-

The 16 states of India are considered to be the decision making units in Rice production. Each state is assumed to combine two single output, The distribution of efficiencies under constant and variable returns to scale and scale efficiencies are given below:

S.NO	STATE/UT	CRSTE	VRSTE	SCALE
1	Westbengal	0.04	0.109	0.363drs
2	Uttarpradesh	0.033	0.035	0.959irs
3	Andhrapradesh	0.05	0.168	0.299drs
4	Punjab	0.109	1	0.109drs
5	Odisha	0.048	0.067	0.711irs
6	Chhattisgarh	0.053	0.076	0.692irs
7	Tamilnadu	0.136	0.583	0.233drs
8	Bihar	0.064	0.093	0.695irs
9	Assam	0.088	0.107	0.824irs
10	Haryana	0.208	1	0.208drs
11	Karnataka	0.167	0.5	0.333drs
12	Maharashtra	0.128	0.173	0.741irs
13	Madhyapradesh	0.103	0.183	0.564irs
14	Jharkhand	0.163	0.186	0.877irs
15	Gujarath	0.253	0.315	0.805irs
16	Kerala	1	1	1
	Mean	0.165	0.350	0.588

RANKING OF DMUs FOR RICE PRODUCTION:

S.NO	STATE/UT	Peers	Peer count	Peer weight	Rank
1	Westbengal	16 10	0	0.667 ,0.333	11
2	Uttarpradesh	16	0	1.000	02
3	Andhrapradesh	10 16	0	0.482, 0.518	13
4	Punjab	4	0	1.000	16
5	Odisha	16	0	1.000	07
6	Chhattisgarh	16	0	1.000	09
7	Tamilnadu	16 10	0	0.221, 0.779	14
8	Bihar	16	0	1.000	08
9	Assam	16	0	1.000	04
10	Haryana	10	4	1.000	15
11	Karnataka	16 10	0	0.607, 0.393	12

12	Maharashtra	16	0	1.000	06
13	Madhyapradesh	16	0	1.000	10
14	Jharkhand	16	0	1.000	03
15	Gujarath	16	0	1.000	05
16	Kerala	16	13	1.000	01

Wheat production:

The 15 states of India are considered to be the decision making units for Wheat agricultural production. Each state is assumed to combine two single output, The distribution of efficiencies under constant and variable returns to scale and scale efficiencies are given below:

S.NO	STATE/UT	CRSTE	VRSTE	SCALE
1	Uttarpradesh	0.015	0.075	0.197drs
2	Punjab	0.067	1	0.067drs
3	Madhyapradesh	0.02	0.046	0.444drs
4	Haryana	0.092	1	0.092drs
5	Rajasthan	0.055	0.343	0.161drs
6	Bihar	0.049	0.101	0.480drs
7	Gujarath	0.098	0.239	0.409drs
8	Maharastra	0.065	0.125	0.516drs
9	Westbengal	0.402	1	0.402drs
10	Uttarakhand	0.338	0.775	0.436drs
11	Himachalpradesh	0.191	0.367	0.521drs
12	Jammu&Kashmir	0.267	0.511	0.523drs
13	Jharkhand	0.59	1	0.590drs
14	Karnataka	0.249	0.425	0.587drs
15	Assam	1	1	1
	Mean	0.233	0.534	0.428

RANKING OF DMUs FOR WHEAT PRODUCTION:

S.NO	STATE/UT	Peers	Peer count	Peer Weight	Rank
1	Uttarpradesh	9 , 4	0	0.877, 0.123	12
2	Punjab	2	0	1.000	15
3	Madhyapradesh	9, 13	0	0.466, 0.534	08
4	Haryana	4	2	1.000	14
5	Rajasthan	9 ,4	0	0.806, 0.194	13
6	Bihar	13 , 9	0	0.741, 0.259	07
7	Gujarath	9 , 13	0	0.867, 0.133	10
8	Maharastra	13 , 15	0	0.517, 0.483	06
9	Westbengal	9	6	1.000	11
10	Uttarakhand	9 , 13	0	0.493, 0.507	09
11	Himachalpradesh	15 , 13	0	0.491 ,0.509	05
12	Jammu&Kashmir	15, 13	0	0.379 ,0.621	04
13	Jharkhand	13	8	1.000	02
14	Karnataka	15 , 13	0	0.795 ,0.205	03
15	Assam	15	4	1.000	01

II. Conclusions

In this paper we analyzed 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 Kerala appeared as an efficient peer state in the peer list of 13 inefficient States in agricultural Production in Rice. Haryana appeared as an efficient peer of 4 inefficient states in agricultural production. We rank the rest of the DMUs based on their pure technical efficiency. The top most and the bottom most Agricultural states are Kerala and Punjab respectively.

In the analysis it has been observed that the Jharkhand appeared as an efficient peer state in the peer list of 8 inefficient States in agricultural Production in wheat , Westbengal appeared as an efficient peer of 6 inefficient states in agricultural production, Assam appeared as an efficient peer of 4 inefficient states in agricultural production , Haryana appeared as an efficient peer of 2 inefficient states in Wheat agricultural production. The top most and bottom most Agriculture states are Assam and Punjab.

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