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- Sharma T., Kwatra, G. (2008) Effectiveness of Social Advertising: A Study of Selected Campaigns, Corporate Social Responsibility, Edited by David Crowther & Nicholas Capaldi, Ashgate Research Companion to Corporate Social Responsibility, Chapter 15, pp 287-303.

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MEASURING EFFICIENCY OF SELECTED STATE INDUSTRIAL DEVELOPMENT CORPORATIONS THROUGH APPLICATION OF DATA ENVELOPMENT ANALYSIS

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ABSTRACT

The role and effectiveness of any State Industrial Development Corporation (SIDC) depends not only on the quantum of its assistance but also the efficiency with which its financial resources are managed. It has direct bearing on the development bank's ability to perform some of its basic functions of mobilising private investment capital for economically important projects and to develop the groundwork for a capital market. This paper is focused on analysing the efficiency of State Industrial Development Corporations (SIDCs) by applying window analysis of data envelopment analysis technique (DEA). Sample consists of four SIDCs of northern states. Inter period and inter-SIDC efficiency has been calculated. Time period covered for inter-temporal analysis is eleven years i.e. from 1993-94 to 2003-04 for all the four SIDCs. Results have shown that some of the SIDCs like HSIDC and PSIDC have shown efficiency in their performance. Mean efficiency score of PSIDC was better than HSIDC but later on HSIDC has shown remarkable improvement. Whereas other SIDCs like JKSIDC are not able to cope with the changing economic environment. Its efficiency score is lowest among all the SIDCs under study.

KEYWORDS
Data Envelopment Analysis, Efficiency, State Industrial Development Corporations

INTRODUCTION

State Industrial Development Corporations (SIDCs) are state level institutions established under the Companies Act 1956 as wholly owned undertakings of State governments for promotion and development of medium and large industries in the respective states. SIDCs, like all other commercial organisations survive by earning a higher return on uses of funds than what they pay for their sources of funds while maintaining risk at tolerable level. They are required to have sufficient resources to give them an opportunity to become self sustaining and enable them to make an attempt on industrial development. The process of financial sector reforms initiated in 1991 have also emphasized that the national and state level financial institutions should function on business principles which further necessitates the need for examining the efficiency of these SIDCS.

The objective of this paper is to measure the efficiency of these SIDCs using data envelopment analysis technique (DEA). Four SIDCs of north Indian states i.e. Punjab, Haryana, Himachal Pradesh, and Jammu & Kashmir namely Punjab State Industrial Development Corporation (PSIDC), Haryana State Industrial Development Corporation (HSIDC), Himachal Pradesh State Industrial Development Corporation (HPSIDC) and Jammu and Kashmir State Industrial Development Corporation (JKSIDC) are selected for comparison. Data Envelopment Analysis is a linear programming technique which uses data on input and output quantities of decision making units. It has been used previously to analyse the relative efficiency of industrial firms, universities, hospitals, military operations etc. Recently number of studies has applied this technique to analyze the efficiency of banks. Efficiency basically is the success with which an organization uses its resources to produce outputs – that is the degree to which the observed use of resources to produce outputs of a given quality matches the optimal use of resources to produce outputs of a given quality.

REVIEW OF LITERATURE

There exists vast literature pertaining to the evaluation of the performance of financial institutions, but most of these studies are concentrated on developed countries. Berger and Humphrey (1997) document a country-wise and methodology-wise review of studies on bank performance. They found that out of 130 performance analysis of financial institutions, including 21 countries, only five percent investigated the banking sectors of developing countries. A few studies assessed the performance of Indian banks and evolved in 1990s. The prominent studies which used the traditional ratio analysis for evaluating the performance of commercial banks include Ajit & Bangar(1997), Mohan(2002), Bhide, Prasad & Ghosh(2002), D'souza(2002), Choudhary(2002) and Rakesh(2004). Most of these studies were descriptive in nature and failed to discover any benchmark for measuring the performance of commercial banks in India which is also one of the shortcomings of ratio analysis. In recent years number of studies has been conducted on Indian banking sector to evaluate the relative performance and productivity of commercial banks. In these studies parametric and non parametric techniques are employed to measure the performance of banks. The prominent research work based on non parametric approach for Indian banking sector include Das & Ghosh(2005), Nag, Ray & Das(2005), Sarkar & Kumbhakar(2005), Ray & Mohan(2004), Pal,Nath& Mukherjee(2002), Das(2002), Ravisankar & Saha(2000). They used Data Envelopment Analysis technique for measuring the relative performance in terms of efficiency. There are few notable research studies based on parametric approach in Indian case including Kumar De(2004), Shanmugam & Das(2004),Naidu & Nair, Sensrama(2005),Srivastva(1999) Bhattacharya (1997), Subarahmanyam & swamy (1994).

All the above mentioned studies have evaluated the performance of commercial bank and there is hardly any study which has measured the performance of development banks in India by using the parametric or non parametric approach. The present study is an attempt to measure the performance of State Industrial Development Banks in India by applying DEA technique.

DATA ENVELOPMENT ANALYSIS

DEA is a methodology for analysing the relative efficiency and managerial performance of productive units having the same multiple inputs and multiple outputs. It is based on non parametric, deterministic methodology for determining the relative efficient production frontier, based on empirical data on chosen inputs and outputs of a number of entities called Decision Making Units (DMUs). Farrell (1957) attempted to measure the efficiency in production in single input and output case. Farell's study involved the measurement of price and technical efficiencies and the derivation of the efficient production function. Farrell applied his model to estimate the efficiency of US agricultural output relative to other countries. However he failed in providing a way to summarise all the various inputs and outputs into a single virtual input and single virtual output.

Charner, Cooper and Rhodes (1978) extended Farrell's idea and proposed a new technique. It generalizes the single–input, single-output measure of efficiency of decision making unit (DMU) to a multiple-input, multiple-output setting. A DMU is an entity that uses inputs to produce outputs. This approach to performance measurement is called data envelopment analysis (DEA). The technique of DEA involves the use of linear programming to solve a set of inter-related problem to determine the relative efficiency of DMUs. The efficiency of a DMU is computed as a rate of virtual output produced to virtual input consumed.

$$\text{Efficiency} = \frac{\Sigma \text{ weighted outputs}}{\Sigma \text{ weighted inputs}}$$

The analysis will measure outputs(s) achieved from the input(s) provided and will compare the group of DMUs by their strength in turning input into output. At the end of the analysis DEA will be able to say which units/branch are relatively efficient and which are relatively inefficient. This mathematical programming technology can be applied to assess the 'relative' efficiency of variety of institutions using a variety of input and output data. The term 'relative' is rather important here since an institution identified by DEA as an efficient unit with a given data set may be deemed inefficient when compared, using another set of data. DEA identifies reference points (relatively efficient DMUs) that define the efficient frontier (as the best practice production technology) and evaluate the inefficiency of other, interior points (relatively inefficient DMUs) that are below- that frontier

For illustration, CCR model (1978), assume that there are n DMUs to be evaluated. Each consumes different amounts of i_{th} inputs and produces r_{th} different outputs i.e. DMU_j consumes x_{ij} amounts of input to produce y_{rj} amounts of output (Coelli 2000; Ray2004)

Let x ∈ R_+^I and y ∈ R_+^m. Assuming constant-return to scale and strong disposability of inputs and outputs and convexity of the production possibility set, the technical efficiency of the sth DMUs can be obtained as:

$$\text{Max. } h_s = \frac{\sum_{r=1}^{m} u_r y_{rs}}{\sum_{i=1}^{l} v_i x_{is}}$$

$$\text{Subject to } \frac{\sum_{r=1}^{m} u_r y_{rj}}{\sum_{i=1}^{l} v_i x_{ij}} \leq 1 \quad \text{for } j = 1,2,...s.....n;\ r = 1,2,.....m;\ i = 1,2,.....l;$$

$u_r, v_i \geq 0$ ----------(i)

Where y_{rs} = the amount of the r_{th} type output produced by the s_{th} DMU; x_{ij} = the input of the i_{th} type used by j_{th} DMU, u_r and v_i are the weights assigned to output and input respectively. The efficiency score of different decision making units is computed by determining the values of weights (u_r, v_i). However, this problem has an infinite number of solutions since if (u^*, v^*) is optimal than h (hu^*hv^*) is also optimal for each positive scalar. To avoid this problem, the above model may be transformed into another linear programming model by restricting the denominator of the objective function h_s to unity and adding this as a constraint to the problem which can be written as

$$\text{Max. } h_s = \sum_{r=1}^{m} u_r y_{rs}$$

$$\text{Subject to } \sum_{i=1}^{l} v_i x_{ij} = 1.$$

$$\sum_{r=1}^{m} u_r y_{rj} - \sum_{r=1}^{l} v_i x_{ij} \leq 0$$

$u_r, v_i \geq 0$; for $j = 1,2,...s.....n;\ r = 1,2,.....m;\ i = 1,2,.....l;$

----------(ii)

For the above linear programming problem, the dual can be written as.

$$\text{min } z_s = \Theta_s$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} \geq y_{rs}$$

Subject to

$$\Theta_s x_{is} - \sum_{j=1}^{n} \lambda_j x_{ij} \geq 0$$

$\lambda_j \geq 0$ *for* $j = 1,2,...s.....n;\ r = 1,2,.....m;\ i = 1,2,.....l;$

----------(iii)

Both the above problems yield an optimal solution $\Theta_s^{\otimes}$ which is efficiency score for particular DMUs and efficiency scores for all Θ_s of them are obtained by repeating them for each DMU_j, *j = 1, 2, …n*. The value of Θ is always less than or equal to unity DMUs for which $\Theta^{\otimes}$ < 1 are relatively inefficient and those for which $\Theta^{\otimes}$ = 1 are relatively efficient.

For introducing variable return to scale, it is necessary to add the convexity condition for the weights λ_j in the form of $\sum \lambda_j = 1$. This type of DEA model is called BCC model, after Banker, Charnes and Cooper (1984).

An advantage of DEA is that it uses actual sample data to derive the efficiency frontier against which each firm in the sample can be evaluated. As a result, no explicit functional form for the production function has to be specified in advance. Instead, the production frontier is generated by a mathematical programming algorithm which also calculates the optimal DEA efficiency score for each firm. In this way, a given firm at a given time can compare its performance at different time and with the performance of other firms at the same time and at different times. Through a sequence of such 'windows' the sensitivity of a firm's efficiency score can be derived for a particular year according to changing conditions and a changing set of reference firms (panel data analysis). A firm that is DEA efficient in a given year, regardless of the window, is likely to be truly efficient relative to other firms. Conversely, a firm that is only DEA efficient in a particular window may be efficient solely because of extraneous circumstances.

RESEARCH METHODOLOGY

For analysing the performance of the development banks over the period, Window approach of DEA is employed in the study. A DEA window analysis is based on the principle of moving average (Charnes et al 1994, Yue 1992) and is useful to detect performance trends of a unit over time. A DMU in each period is treated as if it is a different DMU. The performance of a DMU is compared with its performance in other periods, in addition to comparing it with the performance of other DMUs in the same period.

The most important step in using DEA to examine the relative efficiency of any type of firm is the selection of appropriate inputs-outputs. Although DEA model avoids the problem of agreeing on a common set of weights for the inputs and outputs, it cannot avoid the problem of selecting which inputs and outputs should be included in the comparison. Clearly, any resources used by a unit should be included as input. A unit will convert resources to produce outputs so that outputs should include the amount of products or services produced by the unit and these products or services may be produced at different levels of quality. In banking literature, there is debate among researchers about what constitute inputs and outputs of financial institutions. Most studies have adopted either the production or the intermediation approach. The former approach view the financial institutions as using purchased inputs in the form of capital, labour and other non-financial inputs to produce deposits and various categories of financial institutions assets like advances, investments etc. (Ferrier and Lavell, 1990). The intermediation approach views that financial institutions are intermediating funds between savers and investors and incur interest expenses and other operating expenses to provide revenue generating services (Sealey and Lindley, 1977). The intermediation approach is most appropriate to the financial institutions like state industrial development corporations. It considers capital, borrowings and establishment expenses as input and loans and advances and investment as output. SIDCs uses capital raised from state government and borrowings from different sources like refinancing from IDBI, SIDBI.

Inputs

X_1 = Capital and reserves
X_2 = Borrowings
X_3 = Establishment expenses

Output

Y_1 = Loans and advances
Y_2 = Investments

To analyse the performance of SIDCs for different periods, input oriented DEA score is calculated. In this research effort all these variables are measured in terms of rupees in lakhs. The data of these variables is taken from the annual reports and official records of SIDCs. The data covered is of eleven years i.e. from 1993-94 to 2003-04 for all the four SIDCs namely HSIDC, PSIDC, HPSIDC and JKSIDC. In this, each SIDC in different period is treated as separate DMU and comparison in made over period of time. It is assumed that period included in each window have same type of environment. However, this assumption is restrictive in nature because of changes in technology, policies and economic conditions which may influence the decision making units. Three years window analysis is used in the study because most of studies reviewed have chosen three year period.CCR input-oriented model is used to arrive at the results. Efficiency Measurement System (EMS) 1.7 computer software is used for analysis.

EMPIRICAL RESULTS

A basic summary of the value of the key variables used in the analysis is presented in Table-1

TABLE 1 SUMMARY OF THE POOLED DATA (1993-1994 TO 2003-04) (Rs. Lakh)

	Capital and Reserves	Borrowing	Establishment Expenses	Loan and Advances	Investment
Mean	6196.974	19112.185	197.36958	12919.689	7266.8521
Std. Deviation	3817.4181	21028.071	109.15746	10278.458	12226.907
Minimum	1800	1669.56	65.66	2343.91	205.15
Maximum	13470.78	65509.07	572.49	36153.29	41889.95

Source: Calculated from Annual Reports of different SIDCs (different years)

The average capital and reserves per financial corporation is Rs. 6196.974 lakh which ranged from Rs. 1800 lakh to Rs. 13470.78 lakh, implies heterogeneity in the capital base of the sampled corporations. Similar type of interpretation we can make about the remaining variables. The question arises whether this type of data which have high variability is fit for analysis. It may be noted that figures presented in the table are the descriptive of panel data and high variability exist in both the output and input variables. Here in our analysis as usual we have assumed that the financial corporations are working in normal conditions, so high level of output is accompanied by high level of inputs and vice versa. However the relative position of output in relation to inputs may vary with respect to time or Individual Corporation or both. With these considered the given data is fit case for our analysis based on DEA approach.

The results of input oriented DEA scores based on the assumption of constant return is presented in table 2 to 5. In each window, the number of SIDCs is tripled because each SIDC at different year is treated as an independent firm. Repeating this procedure for each window, DEA efficiency score of every SIDC during the eleven year period has been obtained. The efficiency scores presented in the tables include the SIDC efficiency scores of a year attained in different windows. For instance the efficiency scores of a SIDC corresponding to the column year 1995 show the relative position of the concerned SIDC with respect to year 1993, 1994 & 1996 along with its relative performance with respect to other SIDCs. The average of thirty three efficiency scores of each SIDC is presented in column developed by mean. A comparison of minimum and maximum efficiency score reveals that the performance at individual level exhibits a marked deviation from the best practice frontier.

The column denoted by GD includes the greatest difference in SIDCs' DEA scores for the same year but in different window. If the difference of this column is highest it means performance of SIDC is not constant. The column labeled TGD denotes the greatest difference in SIDC's DEA scores for the entire period. A SIDC can receive a different DEA efficiency score for the same year in different window. This variation in DEA scores of each SIDC reflects both the performance of SIDC over time as well as that of other SIDC. Table-5.2 to 5.5 also presents the mean score of efficiency of each year for every SIDC separately which provide us one figure in each year.

HSIDC's efficiency score varied in different periods. In 1999 efficiency is at minimum. It is 77.9 percent efficient. Mean score of efficiencies in different periods has also shown mixed trend. It varied between 100 percent efficient to 87 percent efficient which implies that HSIDC exhibit marked deviations from the best practice frontier. Overall efficiency of HSIDC has improved in the last three windows (Table 2). Mean score of overall efficiency shows that corporation can reduce its input by 4 percent to produce same level of output. It implies that HSIDC is not able to utilize its resources fully and needs to make concerted efforts in this regard. GD is maximum in 1998 at 16.9 percent which implies the inconsistency in the performance. TGD is 22 percent over the period under study which indicates the variation in overall performance over a period under study.

TABLE 2 DEA EFFICIENCY SCORES OF HSIDC (1993-2004)

Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	mean	SD	max	min	GD	TGD
Windows													0.96	0.06	1	0.78	.169	.22
W1	1	0.898	1															
W2		0.891	1	0.947														
W3			1	0.962	1													
W4				1	1	0.958												
W5					1	0.83	0.779											
W6						0.999	0.855	0.9										
W7							0.933	0.943	1									
W8								0.866	0.909	1								
W9									0.943	1	1							
W10										1	1	1						
W11											1	1						
W12												1						
Mean of Year	1.00	0.89	1.00	0.97	1.00	0.93	0.86	0.90	0.95	1.00	1.00	1.00						

Source :Computed from the financial data of SIDCs

The efficiency scores of PSIDC over a period of eleven years is shown in table 3. In the initial years PSIDC was operating at hundred percent efficiency in comparison to the other DMUs under study but in later years it showed fluctuating trends. Overall efficiency score in all windows and all years was 99 percent. Its minimum efficiency score is 91 percent in 2004. Overall efficiency score of the period under study is 99 percent. Its GD is highest in 2004 at 8.8 percent and its TGD is also same. It shows that performance of PSIDC varied between 100 percent to 91

percent. Mean efficiency score in twelve windows is less than hundred. But overall efficiency score of PSIDC is higher in comparison to other SIDCs.

TABLE 3 DEA EFFICIENCY SCORES OF PSIDC (1993-2004)

Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	mean	SD	max	min	GD	TGD
Windows													0.99	0.02	1	0.91	.088	.088
W1	1	1	1															
W2		1	1	1														
W3			1	0.95	1													
W4				1	0.99	1												
W5					0.99	1	1											
W6						1	1	1										
W7							1	1	1									
W8								1	1	1								
W9									1	1	1							
W10										1	1	0.91						
W11											1	1						
W12												1						
Mean of year	1.00	0.89	1.00	0.97	1.00	0.93	0.86	0.90	0.95	1.00	1.00	1.00						

Source :Computed from the financial data of SIDCs

Table 4 presents the efficiency scores of HPSIDC. Its efficiency scores has shown decreasing trend over a period of time. Efficiency scores of HPSIDC is minimum in the year 2000 at 71 percent. It implies that the corporation can save up to .291 units of input for producing the same output. GD is .289 in the year 2000 and variation is maximum in the year 2000 only. Mean efficiency score in different windows is 83.8 percent in 1998-2000. It means corporation can save upto 16.2 percent for producing same output. Values related to standard deviation reflect consistent performance of HPSIDC.

TABLE 4 DEA EFFICIENCY SCORES OF HPSIDC (1993-2004)

Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	mean	SD	max	min	GD	TGD
Windows													0.96	0.06	1	0.71	.289	.289
W1	1	1	1															
W2		1	1	1														
W3			1	1	1													
W4				1	0.96	1												
W5					1	1	0.8											
W6						1	0.8	0.71										
W7							1	0.97	0.92									
W8								1	0.96	1								
W9									1	0.93	0.92							
W10										0.94	0.9	1						
W11											0.9	1						
W12												1						
Mean of year	1.00	0.89	1.00	0.97	1.00	0.93	0.86	0.90	0.95	1.00	1.00	1.00						

Source :Computed from the financial data of SIDCs

Table 5 shows the performance of JKSIDC over the period of eleven years. Efficiency of JKSIDC is minimum among all the four SIDCs. Mean of efficiency score of JKSIDC is also lowest at 88 percent. High value of standard deviation also reflects inconsistency in the performance of the corporation. Its efficiency score is minimum at 66 percent in 1998 and is consistent in all the three windows. It implies that corporation, if utilized its resources efficiently could have saved 34 percent of input for producing same output. JKSIDC showed consistently efficient performance in the year 2001 only. Overall performance of JKSIDC is not satisfactory. Corporation is not able to utilize its resources fully. Inter temporal analysis reveals that overall efficiency in later years has improved in comparison to earlier years.

TABLE 5 DEA EFFICIENCY SCORES OF JKSIDC (1993-2004)

Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	mean	SD	max	min	GD	TGD
Windows													0.88	0.11	1	0.66	.193	.34
W1	0.885	0.9	0.9															

W2		0.853	0.9	0.899														
W3			0.928	0.928	0.793													
W4				0.924	0.657	0.66												
W5					0.657	0.66	0.812											
W6						0.66	0.951	0.776										
W7							1	0.913	1									
W8								0.969	1	0.933								
W9									1	0.933	0.971							
W10										0.932	0.969	0.945						
W11											0.97	0.945						
W12												0.947						
Mean of year	0.88	0.88	0.91	0.92	0.70	0.66	0.92	0.89	1.00	0.93	0.97	0.95						

Source: Computed from the financial data of SIDCs

DISCUSSION OF FINDINGS

Comparison of the results of different SIDCs reveals that HSIDC and PSIDC have been performing better than HPSIDC and JKSIDC. Mean efficiency score of PSIDC were higher, in comparison to HSIDC in the initial years. But in later years HSIDC has shown remarkable improvement. Its efficiency score is equal to one in last three years and is consistent in different windows. Average efficiency score of HPSIDC has shown wide fluctuations which is revealed from the fact that maximum efficiency score of the corporation is hundred and minimum 71 percent. Its TGD is also highest JKSIDC's technical efficiency score is lowest among all the four corporations under study. It implies that it has lagged behind which may be attributed to the overall environment of state. Industry in the state is badly effected due to turmoil which has put direct impact on the performance of the corporation.

CONCLUSION

State Industrial Development Corporations have played a great role in the industrial development of states. Apart from providing long-term loans, equity capital, guarantees and underwriting functions they also helped in upgrading the managerial and entrepreneurial skills of the assisted units. But during the last decade the contribution made by these SIDCs in industrial development of their respective states has diminished except in few SIDCs. Some SIDCs are able to cope up with the changing economic environment whereas others have given up. It is evidenced through the in-depth analysis of their performance. Moreover from being in sellers market to be in buyers market asks for change in attitude, which has not been forthcoming from these corporations. They are required to improve their operational efficiency. They need to reduce their cost of operations. Efficiency in funds mobilisation and deployment is required. For these corporations to survive in this competitive environment they must consolidate their financial position.

LIMITATIONS OF THE STUDY

Present study is based on sample data of four state industrial development corporations of northern states and its generalization of results to all SIDCs may have some inherent problem as all the SIDCs may not be functioning in same economic and social environment. The study does not take into account non economic factors like political, social and international behind the performance of these SIDCs which could be quite important. Limitations of measures chosen to analyse and interpret the data are inherited in the study.

DIRECTIONS FOR FUTURE RESEARCH

This study has concentrated on SIDCs of northern states. It can be extended to other SIDCs and development financial institutions also. There are other methods of measuring the efficiency and productivity also, those can be applied and results compared. Impact of high level of nonperforming assets on the performance of these SIDCs can also be studied.

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