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EVALUATING EXCESSES AND SHORTFALLS IN PRISON SERVICES

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ABSTRACT

Using data envelopment analysis, an unbiased index was establish by evaluating the ability of states to maximize their objectives subject to minimizing some conditions (inputs). This approach, which rank state from the most robustly efficient to the most robustly inefficient in its ability to maximize goals (output), while minimizing conditions (input) avoid using equal or subjective weight employed in conventional ranking scheme. The ranking of 36 states yield unexpected result and suggest a very different way of measuring and evaluating development policy.

KEY WORDS: Data Envelopment Analysis, Decision Making Unit

INTRODUCTION

Data Envelopment Analysis (DEA) is a mathematical programming methodology based on the Frontier approach. It has been successfully used to study the comparative performance of units that consume similar inputs and produce similar outputs. The units are generally referred to as Decision Making Units (DMUs). Certain benefits are derived when measuring productivity. These include identifying dimension on which to improve productivity. Others providing useful information to management of DMU and indicating target in order to guide future operation (Farrell, 1957; Cooper et al., 2007). DEA provides an approach for achieving efficient targets for inefficient operation (Charnes et al., 1978). The input oriented models consider the possible ratio input reduction while maintaining the current level of output. Whereas the output oriented model consider possible ratio output augmentation while keeping the current level of inputs. The objective of this study is to track down the relative efficiency of states in terms of provision of prison services in comparison with one another using four attributes. In doing so, states that have excess inmate in captivity and those that have shortfall of prison capacity will be identified hence target for achieving efficiency will be provided.

To the best of our knowledge, DEA has not been employed to study the socio economic performance of states in terms of prison services. In Nigeria, this paper therefore helps to provide a comparative picture of performance of states. The paper is organized as follows: In section 2, methodology is presented. In section 3, data is presented and summarized. In section 4, the results are presented and the determinant of efficiency is analyzed. In section 5, policy implication is drawn. Finally, in section 6, the conclusions are derived.

Slack Based Models (SBM)

The productivity measurement approach used in this paper adopts the slack base model (Charnes et al., 1985), which focus on the two ï stage process that can identify inefficient in the form of input and output slack. SBM shows that these input and output slack optimized directly to identify the efficient frontier. SBM is a unique appropriate index, since it is neither input-oriented nor output oriented. Rather, it simultaneously minimizes conditions (input) while maximizing goals (output) (Charnes et al., 1994). In order to consider both input decrease as well as an output increase simultaneously, the inputs are reduced proportionately, and the outputs are increased in different proportion. Model (1) identify a CRS frontier, and therefore, is called CRS additive model.

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$$Object. \equiv \max\left(\sum_{i=1}^{m} s_i^- + \sum_{r=1}^{s} k_r^+\right)$$

$$subject.to:$$

$$\sum_{j=1}^{n} \lambda_j x_{ij} + s_i^- = x_{i0}, i = 1,...,m$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} - k_r^+ = y_{r0}, r = 1,...,s$$

$$\lambda_j, s_i^-, s_r^+ \geq 0; j = 1,...,n$$

In linear programming terminology, the objective function is to maximize the sum of all specific national development goals subject to minimizing specific resource availability indicators. These goals are observations measured and represented as outputs and denoted by $y_{rj}(r = 1,...,s)$. The resource availability indicators are observations measured and represented as inputs and denoted by $x_{ij}(i = 1,...,m)$. Let: s_i^- be an input slack; k_r^+ be an output surplus and λ_j be a set of unknown weights (decision variables), where $j = 1,...,n$ corresponding to each DMU, in this paper, $n = 36$. Four measures were used. They are as follows:

- **Inputs $(i = 1,2,3; m = 3)$**
  - Male
  - Female
  - Number of prisons
- Outputs (r = 1; s = 1)
  - Prison capacity
- 36 State (DMU)
  1. J = 1,. . . , 36
  2. n = 36

There is a need to run DEA model (1) 36 times, one for each DMU (state) in order to determine whether we can find a set of weights so that the convex combination of these 36 states perform better than one of the 36 states. If the answer is yes then the targeted state (DMU_0) is inefficient, otherwise if the answer is no then the targeted state (DMU_0) is efficient

Data

Data is obtained from the National Bureau of Statistics publications (NBS, 2009). Thirty six (36) states in Nigeria including the Federal Capital Territory (FCT) were employed as DMU. Due to lack of data on Bayelsa state, it was not considered in the analysis. Male and female inmates were employed as inputs variables and the maximum capacity of the prison houses represents the output variable. With these conditions (inputs) to be minimized and goal (output) to be maximized, the form of the proposed model is given as SBM (1) above. The analysis assumes Constant Return to Scale (CRS). CRS is said to prevail when an increase in all input by 100\% leads to corresponding increase in all output by 100% (Golany and Thore, 1997). The reason is obvious, that CRS measures technical efficiency and efficiency loss when the DMU does not operate in its most productive scale size. Table 1 shows data summary.

Table 1: Descriptive statistics on input and outputs data

	Male	Female	Prison	Capacity
Max	3,762	140	17	3,422
Min	301	1	1	200
Mean	1,082.861	19.667	6.308	1,302.944
SD	724,024	22.780	4.088	742.457

Measures of central tendency such as mean and measure of dispersion such as standard deviation, maximum and minimum values are shown against their respective input variables. Table

Table 2: Correlation coefficient

Output		Male	Female	Prison	Capacity
Input:					
	Male	1	0.798	0.187	0.574
	Female	0.798	1	0.011	0.452
	Prison	0.187	0.011	1	0.740
	Capacity	0.574	0.452	0.740	1

2 shows the results obtained from the correlation analysis. After selecting input and output variables, correlation coefficient is tested to ascertain whether variables have isotonic relationship, i.e. decreasing input increase efficiency and increasing output increase efficiency. As shown in Table 2, all the variables selected are positively correlated.

RESULTS

DEA solver professional version 5.0 software was employed for computation. The result indicates 6 best performing states with performance score of 100% each. These states are Zamfara, Osun, Lagos, Jigawa, Borno and Benue. The states, which rank top on the list of efficient frontier, have no male and female excess in captivity, and no excess Prisons capacity. The remaining 29 states including Abuja are inefficient with performance score less than 100%. This ranking is in accordance with preference position. The least is Oyo state with performance score of 30.31%. Target is set for inefficient states in order to reach efficiency. For instance, Oyo can reduce her male inmates by 77.20% from 692 to 534 as well as its inmates, female by 68.72% from 11 to 8. Similarly, prison houses can be reduced by 63.14% from 2 to 1. Similar analysis can be done to project the remaining 29 inefficient states. The overall sources of inefficiencies are also shown in table 3. The table depicts in detailed excess inputs at each states. For instance, Adamawa state had 651 excess in male inmates, 8 excess in female, 6 excess in prison houses, and no shortage of facility. The total number of male inmates in Nigeria prisons is 38,983 and 708 of female inmates spread across 227 prisons. This brings to the grand 39,691 to inmates in Nigerian prison. The maximum capacity of the 227 prisons studied is 46,706. The study also reveals that there is more capacity than the number of inmates in Nigeria prisons.

Table 3 also gives information about peer (s) for state considered inefficient in the analysis. Peer(s) are efficient states with a performance score of 100% and all slacks at zero level. Abia's peer is Benue, meaning that Abia can try to emulate Benue by achieving better values of attributes that would result in an efficiency score of 100%. Note that Borno is considered as peer for many of the inefficient countries. Interestingly, Lagos and Zamfara are not considered as peers for any inefficient states. This might have resulted from the existence of alternate optima (Cook and Zhu, 2008).

Table 3: Distribution of scores, sources of inefficiency and peers in overall performance

Serial No.	DMU Names	Score 100%	Excess Male	Excess Female	Excess Prison	Shortage Capacity	Peer(s) Group
1.	Abia	54.83	652	13	1	0	[6]
2.	Adamawa	58.87	651	8	6	0	[7]
3.	Akwa Ibom	74.99	299	8	0	0	[6], [7]
4.	Anambra	35.74	784	19	1	0	[6]
5.	Bauchi	15.03	462	5	7	0	[7]
6.	Benue	100.0	0	0	0	0	[-]
7.	Borno	100.0	0	0	0	0	[-]
8.	Cross River	56.68	388	11	1	0	[7]
9.	Delta	42.01	789	16	3	0	[6]
10.	Ebonyi	54.51	438	4	1	0	[28]
11.	Edo	61.95	614	20	2	0	[6]
12.	Ekiti	45.01	241	2	0	0	[7]
13.	Enugu	56.18	611	18	1	0	[6]
14.	Gombe	41.21	357	5	2	0	[7]
15.	Imo	54.76	841	17	0	0	[6]
16.	Jigawa	100.0	0	0	0	0	[-]
17.	Kaduna	61.22	1,345	8	2	0	[7]
18.	Kano	44.18	1,519	22	2	0	[7]
19.	Katsina	35.39	725	29	4	0	[7]
20.	kebbi	60.37	567	3	3	0	[7]
21.	Kogi	43.88	220	2	2	0	[16]
22.	Kwara	40.84	229	1	1	0	[16]
23.	Lagos	100.0	0	0	0	0	[-]
24.	Nassarawa	59.12	260	2	0	0	[7],[16]
25.	Niger	50.09	432	23	2	0	[7]
26.	Ogun	45.16	848	9	3	0	[28]
27.	Ondo	35.42	479	13	3	0	[6]
28.	Osun	100.0	0	0	0	0	[-]
29.	Oyo	30.31	534	8	1	0	[6]
30.	Plateau	88.51	259	1	0	0	[7],[28]
31.	Rivers	45.02	2,547	18	1	0	[6]
32.	Sokoto	57.71	743	2	1	0	[7]
33.	Taraba	60.14	350	4	5	0	[7]
34.	Yobe	55.72	216	7	3	0	[7]
35.	Zamfara	100.0	0	0	0	0	[-]
36.	FCT, Abuja	47.54	490	6	1	0	[6]

Policy implication

The result of this study has interesting policy implications for the development of Nigerian prisons. The researcher wish to stress here that the findings of this study are critically based on the choice of attributes (data) and hence, the policy implications discussed below should be considered within this perspective. This study revealed that 16.67% of the 36 states studied are efficient. The smallest CRS efficiency score is 30.31%, which is Oyo state. This is a significant result highlighting the wide disparity in socio-economic status amongst states in Nigeria.

CONCLUSION

The paper attempted to look into issues related to the appraisal of prison services in Nigeria for the year 2009. A CRS additive DEA model was applied to simultaneously identify the excesses and deficits in Nigerian prison services. Various attributes were selected for the purpose of assessment. First, the evaluation of overall performance shows that 16.67% of 36 states are efficient while 83.33% are inefficient. This does not exhibit good performance. The study demonstrates that 98.22% of the total inmates are male, while female inmates constitute 1.78%. Furthermore, the study revealed that there is no shortage of prison capacity. In assessing services, the inefficiency in performance is actually caused by an excess input rather than a deficit in output. DEA provides efficient input and output targets for reducing the excess and improving the deficits. As for future developmental plans, forecasts of inputs and output values can be included in a DEA analysis so that decision makers can determine which factors negatively or positively affect estimation and therefore adjust the economic

development policies. DEA is a method that can be used for monitoring, planning and improvement in the performance of a system.

REFERENCES

Charnes, A., Cooper, W.,Glony, B., Seiford, L. and Stutz, J., 1985. Foundation of data envelopment analysis for pareto-koopmanôs efficient empirical production functions. Journal of Econometrics. 30 (1): 1-17.

Charnes, A., Cooper, W. and Lewin, A., 1994. Data envelopment analysis, theory methodology and application. European Journal of Operations Research. 5(2): 159-163.

Charnes, A., Cooper, W. and Rhodes, E., 1978. Measuring the efficiency of decision making units. European Journal of Operations Research. 2(6): 429-444.

Cook, W. and Zhu, J., 2008. Data envelopment Analysis: modeling operation processes and measuring productivity. 1st Edition. Canada: Springer Science.

Cooper, W., Seiford, L. and Tone, K., 2007. Data Envelopment Analysis: A Comprehensive text with Models Applications. 2nd Edition. New York: Springer Science.

Farrell, M., 1957. The measurement of productive efficiency. Journal of the Royal Statistical Society. 120(3): 253-290.

Golany, B. and Thore, S., 1997. The economic and social performance of nations: efficiency and returns to scale. Socio Economic Planning Sciences.31 (3) 191--204.

NBS, N., 2009. National Bureau of statistics. Retrieved on December 31, 2012 from www. Nigerianstat.gov.ng.