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DATA ENVELOPMENT ANALYSIS: AN APPLICATION TO MEASURE STATE POLICE EFFICIENCY IN INDIA

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Abstract The paper addresses the issue of measuring efficiency of police in India using Data Envelopment Analysis, a relative efficiency measuring technique. The basic organizational structure and uniformity of policing work irrespective of size, population etc., befits DEA modelling to be applied to find out police efficiencies. The CCR output model is used herein to calculate efficiencies. The major aim of the study was to compute the relative efficiencies of the state police units in India; identify the efficient referent units whose best practices could be emulated by the peers in the peer groups formed using DEA approach to efficiency calculations. It was also aimed to analyse what kind of changes in output are needed to improve upon the relative efficiency of the decision-making units. The paper measures the efficiencies of individual states/UTs for the year 2015 and also suggests the possibilities of improvements in the Decision Making Units(DMUs) by creating referent units, identifying slacks and analysing lambda values. The chosen inputs for the study from review of literature are: Total Police Expenditure in Rupee crores(TPE), Civil police per lakh of population (CVPL), Total Police per lakh of Population (TPPL), Total Cases for Investigation (TCI) and Number of Capital Equipment Used (NCEU). The outputs selected for the analysis are: Special and Local Laws cases charge-sheeted (CSS-SLL); Indian Penal Code cases charge-sheeted (CSS-IPC), Number of persons Convicted (NPCON) and Number of Trials Completed (NTCOM).

The CCR output oriented model of DEA is thus used for analysis herein to examine the relative efficiency of state police units in India. The results so obtained suggest ways in which many State/U.T. police departments can improve the overall efficiency in relation to other States/UTs. The lambda values so generated also suggest as to which of the efficient referent unit the inefficient State police units emulate for its best practices to be followed. Among the 29 state police units and very unlikely states like Bihar, Uttar Pradesh, Chhattisgarh have been found to be the relatively efficient ones and Manipur has come out to be in need of major transformation to come up to the level of its relatively efficient peer state police unit of Kerala. The larger lambda value efficient referent unit should be followed by the inefficient state unit. State Police Units of Madhya Pradesh(which occurs 10 times in frequency table) and Kerala(both appearing 10 times as efficient peer); followed by Chhattisgarh & Haryana(occurring 7 times as efficient peer). Discrimination of Efficient State Police Units from frequency of appearing in reference has also been done thereby using the information in categorising the state police units into Highly Robust State Police Units and Marginally Robust State Police Units. Besides the above discrimination, an attempt was made to discriminate the inefficient state police units as well for which the quartile values of efficiency scores were used into 'into four categories-'most inefficient', 'Below Average', 'Above Average' and 'Marginally inefficient units.'

Keywords: Efficiency, state police units of India , Data Envelopment Analysis(DEA), reference units.

1.0 Introduction

Efficiency per se can be rated as more or less, or perhaps an organization can be stated as being more productive or less productive. Thus, we can say there are many ways to emphasise upon the rate of success of a particular organization. Simple fundamental of ratios is used to calculate productivity(calculated as the ratio of input used to the output obtained). Say, Labour productivity needs to be calculated, we take the ratio of units of labour utilized to the output obtained and if capital productivity needs to be calculated, we may take the ratio of units of capital utilized to the total output so obtained. In the productivity so calculated the inputs and outputs used ought to be chosen so that their ratio remains the ratio of two scalar values only. Another way to define efficiency could be to compare the observed maximum potential output of an organization to its optimal inputs required to produce the output. In the paper , the author has also chosen this meaning of efficiency and tried to analyse the relative efficiencies amongst its peer group of decision making units.

Under the Seventh Schedule of the Constitution, the administrative powers are segregated amongst the Central and State governments of India. Police is to be governed by State Laws as per this schedule, thereby making police a State subject to be governed by State laws. The Police Act,1861 is the prominent legal instrument governing the performance of police in general, and police in Indian states, in particular (Verma and Gavernani, 2006). The prime task of police is assumed to be crime control though factually speaking it is way beyond just that. As far as already existing literature is concerned, very limited analysis is available on Indian state police units, which provided ample reason to study the state police efficiency in India. The technique of Data Envelopment Analysis(DEA) was chosen as it is a non-parametric analysis and efficiency of the decision-making units(DMUs) is compared to its own peers in the group rather than an absolute comparison. The inputs and outputs chosen for the DEA technique in the analysis were so chosen as to include the cases charge sheeted, cases investigated etc which indicate the 'crime control' component of police activity.
Traditionally, crime control was considered to be the main policing activity, based on which, most of the economic researchers were then calculating efficiency also on the basis of inputs and outputs representing this main premise only. Though many studies considered external factors like geographical area, socio-economic issues and technological changes as well in their research and analysis about efficiency and/or performance of state police units. In the light of above, the researcher has tried to analyse the efficiency concept for the year 2015 using the data envelopment analysis (DEA) technique. The Research Paper has been structured in the following 7 sections. Section 1 deals with the Introduction and objective of the paper; Section 2 deals with the methodology of the research paper; in Section 3 data analysis and interpretation has been taken into consideration; Section 4 is the conclusions about the research; and Section 5 deals with the limitations and future scope of the study.

1.1 Efficiency Estimation-The Consideration for DEA:

Efficiency signifies a peak level of performance that uses the least amount of inputs to achieve the highest amount of output. It requires reducing the number of unnecessary resources used to produce a given output including personal time and energy. It is a measurable concept that can be determined using a ratio of useful output to total input. It minimises the waste of resources such as physical materials, energy and time while accomplishing the desired output (Banton, Investopedia). Therefore, for the estimation of efficiency, the careful selection of inputs and outputs is of utmost importance.
The efficiency measurement estimation is segregated into two prime groups-the techniques that measure absolute efficiencies and the techniques that measure relative efficiencies, i.e., frontier models and non-frontier models respectively. According to Aristrovnik et al (2013), the frontier models measure absolute efficiency which is a measure of maximum theoretically possible performance of a police force (eg. the resources are utilised in the best possible manner). It is not considered to be measurable (PSPP,2000). And, the non-Frontier models measure relative efficiency, i.e., compare performance levels whilst recognising that even the best relative performers should not be standing still, but improving their performance over time (PSPP,2000). Drake & Simper (2003) compare four different distance function models i.e. DEA, free disposal hull (FDH) (Tulkens, 1993), super-efficiency DEA (Anderson & Petersen, 1993) and stochastic frontier analysis (Banker, 1993; Banker and Maindiratta,1992) in order to assess police force efficiency of English and Welsh police force. It does not highlight limitations of parametric and non-parametric approaches in case of different crime zones which is present in the data.

The review of literature related to efficiency estimation regarding police precincts or units can also be classified as studies (till late 1980s and early 1990s) being based on non-frontier econometric models, prominent among them being Hirsch,1968; Swimmer, 1974; Carr-Hill and Stern, 1977; Levitt and Joyce, 1987; Gyapong and Gyimah-Brempong, 1988; Cameron,1989 and Jackson 1992. Post this period, however, there has been estimation of efficiency using DEA no parametric frontier methodology to analyse efficiency of n parametric frontier techniques (Tannassoulis,1995; Carrigton et al, 1997; Nyhan and Martin, 1999; and Stone,2002). Most of the above studies are of advanced economies like USA and UK. Ticio and Mancebon,2002 also used DEA methodology to analyse efficiency of National Research in areas of public safety rather.

In early 2000's apart from using DEA to evaluate efficiencies of local police units, Aristovnek et al.2013 even considered to evaluate efficiency of police units by controlling for external (environmental) factors. Also, Kumar,2013 used stochastic frontier analysis framework in a 'single stage' to measure the role of police modernisation scheme in its performance in crime repression. Drake & Simper,2001; Sanchez,2008; and Gupta et al,2008 have used public and road safety, DEA & clustering; DEA & SFA respectively in their research papers on not only measuring police efficiency but also in reducing the vast number of potential indicators of police efficiency measurement to a handful allowing feasible estimation too. Around this time, Kumar and Gulati,2008 used the technique of data Envelopment Analysis to measure the extent of technical, pure technical and scale efficiencies in 27 Public Sector banks. Overall García-Sánchez (2007) found that the "economic works on the functions of police production can mainly be found in the empirical area and can be classified into two categories: those that attempt to test the postulates of the economics of crime through non-frontier methods; and those that concentrate on evaluating efficiency by means of frontier techniques".

Drake, Leigh and Simper, Richard(2001) in their paper, "An Economic Evaluation of Inputs and Outputs in Policing: Problems in Efficiency Measurement" emphasised the fact that the new Labour government recently instigated an initiative to establish whether English and Welsh police forces should be ranked into groups based on an efficiency measure. The estimation techniques proposed in the Public Service Productivity Panel (2000) report in order to rank the efficiency of forces are Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA). These procedures allow for multiple input/output configurations in a cost or production model in order to obtain efficiency scores. In order to produce comparative efficiency measures, however, it was essential that the services provided by police forces (the outputs or outcomes) be related to the resources (inputs) utilised by the forces in delivering these outputs (outcomes). A particular problem, however, was that policing included many inputs and outputs (outcomes) that could potentially be utilised in an efficiency model using DEA and SFA. Hence, this paper considered the problems associated with measuring relative police force efficiency given that a vast number of potential indicators must be reduced to a handful to allow feasible estimation. In addition, it discussed the input and output variables utilised in the first 'official' analysis of English and Welsh police force efficiency.

The major aim of the study was to compute the relative efficiencies of the state police units in India; identify the efficient referent units whose best practices could be emulated by the peers in the peer groups formed using DEA approach to efficiency calculations. It was also aimed to analyse what kind of changes in output are needed to improve upon the relative efficiency of the decision-making units.

2.Methodology

The methods so far used for efficiency analysis primarily concern themselves with average based analysis which does not effectively identify the 'best practices' unit. It is DEA approach which overcomes the above problem as it is a linear programming based method to assess the relative efficiencies of DMUs wherein many inputs and outputs can be simultaneously considered to not only identify relatively efficient DMUs but also identifies the peer group of the referent DMU from which the best practices can be transferred. The organisational structure and general working of all state police units is similar with minor differences like working in vernacular languages which does not seem to be a factor affecting the performance evaluation per se. The study constitutes the analysis of relative police efficiency of all states of taken from the compilation of crime data of India by the National Crime Records Bureau, NCRB in their annual publication titled Crime in India. As the unit of command for the functioning of police in India is the state government, the researcher has chosen the unit of analysis to be the state police only. And the data for the state police units was analysed using DEA approach and police units of Union Territories of India were excluded.

Although DEA is a powerful optimization technique to assess the performance of each decision-making unit (DMU) yet it has certain inherent limitations which need to be addressed at the initial stages of decision making itself. The Discriminatory power of the DEA is limited when the number of inputs and outputs is significantly large related to a

relatively smaller proportion of number of DMUs concerned. This is settled by the analyst by having adequate numbers of degrees of freedom (adequate discriminatory power of the DEA model). Cooper et al. (2007) said that n (number of DMUs) should exceed the number of inputs, m and outputs, s by several times. (rule of thumb formula is: n> max{m*s,3*(m+s)}. In the present study, the researcher has thus taken 5 inputs and 4 outputs {29>3(5+4)} to derive the results of the analysis and duly taken care of not affecting the discriminatory power of the DEA model.

The chosen inputs for the study from review of literature are: Total Police Expenditure in Rupee crores(TPE), Civil police per lakh of population (CVPL), Total Police per lakh of Population (TPPL), Total Cases for Investigation (TCI) and Number of Capital Equipment Used (NCEU). The outputs selected for the analysis are: Special and Local Laws cases charge-sheeted (CSS-SLL); Indian Penal Code cases charge-sheeted (CSS-IPC), Number of persons Convicted (NPCON) and Number of Trials Completed (NTCOM).

Also, it was assumed that in order to convert crimes to clear ups, constant returns to scale would hold as the best proposition. The CCR output oriented model of DEA is thus used for analysis herein to examine the relative efficiency of state police units in India.

3 Data Analysis

Based upon the review of literature and own preliminary analysis, five inputs and four outputs(details provided above) were chosen in seeking to measure the relative efficiency of state police units of India. The assessment of police performance herein is in tune with that of Thanassoulis(1995) in the focus of research on crime clear ups. The data for India in this regard is generated in the Reports of National Crime Record Bureau(various years).

3.1 Projected values of inputs and outputs for DMUs

From the Table Nos.1 & 2, the DEA has led us to conclude from the values of projections for inputs and outputs as to which inputs/outputs value needs to be increased or lowered or remain unchanged. The state police units for whom the value of input 'Total Police Expenditure-TPE' is projected to remain unchanged for them to be relatively efficient are: Assam, Bihar, Chhattisgarh, Gujarat, Haryana, Karnataka, Kerala, Madhya Pradesh, Mizoram, Nagaland, Tamil Nadu, Telangana, Uttar Pradesh, Uttarakhand and West Bengal. The state police units for whom the value of input 'Total Police Expenditure-TPE' is projected to reduce for them to be relatively efficient are: Andhra Pradesh (suggested to reduce TPE from 2680.35 rupee crores to 1881.46 rupee crores), Arunachal Pradesh (to reduce from 578.1 to 50.80), Goa (266.23 to 59.28), Himachal Pradesh (675.13 to 359.14), Jammu & Kashmir (3204.18 to 837.54),

Table No.1 Raw values of inputs and outputs chosen-2015

DMU Name	TPE	CVPL	TPPL	TCI	NCEU	CSS-SLL	CSS-IPC	NPCON	NTCOM
Andhra Pradesh	2680.35	97.88	110.1	164218	11013	11854	91857	64	61834
Arunachal Pradesh	578.1	567.88	880.45	6229	1169	155	1973	0	130
Assam	1275.77	88.15	163.81	216357	5706	1972	48612	0	21648
Bihar	4179.64	55.83	69.79	246905	2502	15070	109158	2	48414
Chhattisgarh	1657.12	147.85	218.83	63141	5284	244873	44477	6	44539
Goa	266.23	267.68	354.62	7269	965	1438	2619	0	1367
Gujarat	2514.6	87.44	119.54	142577	14439	301688	105833	28	72557
Haryana	2554.77	133.27	156.29	99154	8230	28056	44175	136	40741
Himachal Pradesh	675.13	131.66	197.54	16794	2428	2982	11275	13	6008
Jammu & Kashmir	3204.18	367.01	569.58	34951	8910	1516	18973	11	12907
Jharkhand	2555.3	128.97	172.4	72135	8259	4706	27175	4	21741
Karnataka	2539.87	106.04	120.47	196686	20995	25120	97631	70	83802
Kerala	2382.72	119.8	140.21	292187	16114	391967	244145	26	138840
Madhya Pradesh	2734.44	88.86	119.86	289365	18691	89665	223867	145	142051
Maharashtra	6595.59	139.25	153.32	420658	25929	134038	174492	139	104982
Manipur	700.96	489.46	984.18	20277	2163	242	460	0	97
Meghalaya	546.18	257.23	457.89	12247	1266	173	1892	0	299
Mizoram	327.33	364.1	915.78	2857	1020	354	2056	0	2160

Nagaland	736.01	385.39	939.54	1819	1853	580	762	11	711
Odisha	2351.42	72.03	119.61	116262	10936	20337	69197	83	41992
Punjab	4339.13	209.26	264.88	64711	6454	20257	23457	39	25020
Rajasthan	3611.08	115.81	134.18	214141	13698	60680	99640	89	84863
Sikkim	314.62	342.34	758.45	950	736	159	397	0	627
Tamil Nadu	5486.08	145.51	164.08	280683	28147	253362	159284	64	178569
Telangana	1491.97	116.11	137.37	150388	10998	10976	87171	26	55548
Tripura	619.53	271.33	637.41	5843	2499	157	3289	0	2329
Uttar Pradesh	8917.25	64.82	78.14	284648	24941	2508223	147631	11	72847
Uttarakhand	955.14	141.81	181.91	11990	3021	87533	5411	4	4931
West Bengal	3085.88	57.05	71.53	262393	9186	22917	160214	0	38844

Source: Reports of the NCRB(various years

Jharkhand (2555.3 to 1345.92), Maharashtra(6595.59 to 3678.70), Manipur(700.96 to 165.35), Meghalaya(546.18 to 99.87), Odisha(2351.42 to 1670.23), Punjab(4339.13 to 1761.79), Rajasthan(3611.08 to 2201.94), Sikkim(314.62 to 107.33) and Tripura(619.53 to 247.25). The state police units for whom the value of input 'Total Police Expenditure - TPE' is projected to remain unchanged for them to be relatively efficient are : Assam (1275.77), Bihar (4179.64), Chhattisgarh (1657.12), Gujarat (2514.60), Haryana (2554.77), Karnataka (2539.87), Kerala (2382.72), Madhya Pradesh (2734.44), Mizoram (327.33), Nagaland(736.01), Tamil Nadu (5486.08), Telangana (1491.97), Uttar Pradesh (8917.25), Uttrakhand (955.14), and West Bengal(3085.88).

The state police units for whom the value of input 'Civil police per lakh of population (CVPL)' is projected to reduce for them to be relatively efficient are: Andhra Pradesh (97.88 to 80.88), Arunachal Pradesh (567.8 to 2.55), Assam (88.15 to 46.64),Goa, (267.88 to 2.98), HP (131.66 to 85.26), J&K (367.01 to 244.50), Jharkhand (128.97 to 114.85), Karnataka (106.04 to 78.51), Maharashtra (139.25 to 113.84), Manipur (489.46 to 8.31), Meghalaya (257.23 to 5.02), Punjab (209.26 to 159.83), Rajasthan (115.81 to 76.63), Sikkim (342.34 to 118.93), Telangana (116.11 o 58.80) and Tripura (271.33 to 240.66). The state police units for whom the value of input CVPL is projected to remain same for them to be relatively efficient are: Bihar(55.83), Chhattisgarh (147.85), Gujarat(87.44), Haryana(133.27), Kerala(119.80), Madhya Pradesh(88.86), Mizoram(364.10), Nagaland(385.39), Odisha (72.03), Tamil Nadu(145.51), Uttar Pradesh (64.82), Uttarakhand(141.81) and West Bengal(57.05).

The state police units for whom the value of input 'Total police per lakh of population (TPPL)' is projected to reduce for them to be relatively efficient are: Arunachal Pradesh (880.45 to 2.99), Assam (163.81 to 550.09), Goa, (354.62 to 3.49), Karnataka (120.47 to 97.87), Manipur (984.18 to 9.73), Meghalaya (457.89 to 5.88), Odisha (119.61 to 88.87), Rajasthan (134.18 to 102.66), Sikkim (758.45 to 299.09), Telangana (116.11 o 58.80) and Tripura (637.41 to 603.11). The state police units for whom the value of input TPPL is projected to remain same for them to be relatively efficient are: Andhra Pradesh (110.10), Bihar(69.79), Chhattisgarh (218.83), Gujarat(119.54), Haryana(156.29), HP(197.54), J&K(569.58), Jharkhand (172.40), Kerala(140.21), MP (119.86), Maharashtra (153.32), Mizoram(915.78), Nagaland(939.54), Punjab (264.88), Tamil Nadu(145.51), Uttar Pradesh (78.14), Uttarakhand(181.91) and West Bengal(71.53).
The state police units for whom the value of input 'Total Cases for Investigation (TCI)' is projected to reduce for them to be relatively efficient are: Assam (216357 to 126319) and Maharashtra (420658 to 289365), The state police units for whom the value of input TCI is projected to remain same for them to be relatively efficient are: Andhra Pradesh (164218), Arunachal Pradesh (880.45 to 2.99), Bihar(246905), Chhattisgarh (63141), Goa, (7269), Gujarat(142577), Haryana(99154), HP(16794), J&K(34951), Jharkhand(72135), Karnataka (196686), Kerala(292187), Madhya Pradesh(289365), Manipur (20277), Meghalaya (12247), Mizoram(2857), Nagaland(1819), Odisha (116262), Punjab (64711), Rajasthan (214141), Sikkim (950), Tamil Nadu(280683), Telangana (150388), Tripura (5843), Uttar Pradesh (284648), Uttarakhand(11990) and West Bengal(262393).

The value of Input 'Number of Capital Equipment Used(NCEU) is projected to reduce for the following state police units for them to be relatively efficient: Arunachal Pradesh(1169 to 343.53), Goa(965 to 400.88), HP(2428

ton1494.57), J&K(8910 to 3261.94), Jharkhand(8259 to 5205.23), Karnataka (20995 to 14895.49), Maharashtra(25929), Manipur (2163 to 1118.27), Meghalaya (1266 to 675.42), Odisha (10936 to 8154.63), Punjab (6454 to 5590.57), Sikkim (736 to 334.49), Telangana (10998 to 9547.72), and Tripura (2499 to 888.43). The value of Input 'Number of Capital Equipment Used(NCEU) is projected to remain same for the following state police units for them to be relatively efficient: Andhra Pradesh(11013), Assam(5706), Bihar(2502), Chhattisgarh(5284), Gujarat(14439), Haryana(8230), Kerala(16114), Madhya Pradesh(18691), Mizoram(1020), Nagaland(1853), Rajasthan(13698), Tamil Nadu(28147),Uttar Pradesh(24941), Uttarakhand(3021) and West Bengal(9186).
The value of output 'Special and Local Law Cases Chargesheeted(CSS_SLL) projected to increase for the following state police units for them to be relatively efficient: Andhra Pradesh(11854 to 88613.10), Arunachal Pradesh(155 to 8356.16), Assam(1972 to 133603.38), Goa(1438 to 9751.32), HP(2982 to 5112.06), J&K(1516 to 47263.70), Jharkhand(4706 to 197762.78), Karnataka(25120 to 95499.86), Maharashtra(134038 to 176814.45), Manipur(242 to 27201.47), Meghalaya(173 to 16429.27), Odisha(10337 to 35083.03), Punjab(20257 to 118409.96), Rajasthan(60680 to 74105.51), Sikkim(159 to 181.92), Telangana(10976 to 145621.74) and Tripura(157 to 5554.61). The value of output 'Special and Local Law Cases Charge sheeted(CSS_SLL) projected to remain unchanged for the following state police units for them to be relatively efficient: Gujarat(301688), Haryana (28056),Kerala(391967), MP(89665), Mizoram(354), Nagaland(580), Tamil Nadu(253362), Uttar Pradesh(2508223), Uttarakhand(87533) and West Bengal(22917).

The value of output 'Indian Penal Code cases Charge sheeted(CSS_IPC) projected to increase for the following state police units for them to be relatively efficient: Andhra Pradesh(91857 to 123211.02), Arunachal Pradesh(1973 to 5204.81), Assam(148612 to 94532.48), Goa(2619 to 6078.82), HP(11275 to 11704.90), J&K(18973 to 26935.72), Jharkhand(27175 to 54700.69), Karnataka(97631 to 138282.68), Maharashtra(174492 to 286404.24), Manipur(460 to 16943.01), Meghalaya(1892 to 10233.32), Odisha(69197 to 78450.98), Punjab(23457 to 36031.79), Rajasthan(39640 to 161811.35), Sikkim(397 to 683.39), Telangana(87171 to 117939.91) and Tripura(3289 to 4664.82). The value of output 'Indian Penal Code cases Charge sheeted(CSS_IPC) projected to remain unchanged for the following state police units for them to be relatively efficient: Bihar(109158), Chhattisgarh(44477), Gujarat(105833), Haryana(44175), Kerala(244145), MP(223867), Mizoram(2056), Nagaland(762), Tamil Nadu(159284), Uttar Pradesh(147631), Uttarakhand(5411) and West Bengal(160214).

The value of output 'Number of persons Convicted (NPCON)' projected to increase for the following state police units for them to be relatively efficient: Andhra Pradesh(64 to 85), Arunachal Pradesh(0 to ~1), Assam(0 to~9), Goa(0 to 1), HP(13 to 14), J&K(11 to ~16), Jharkhand(4 to ~8), Karnataka(70 to ~87), Maharashtra(139 to 184), Manipur(0 to ~2), Meghalaya(0 to ~1), Odisha(83 to ~89), Punjab(39 to ~54), Rajasthan(89 to ~109), , Telangana(26 to 35) and Tripura(0 to ~1). The value of output 'Number of persons Convicted (NPCON)' projected to remain unchanged for the following state police units for them to be relatively efficient: Bihar(2), Chhattisgarh(6), Gujarat(28), Haryana(136), Kerala(26), MP(145), Mizoram(0), Nagaland(11), Sikkim(0), Tamil Nadu(64), Uttar Pradesh(11), Uttarakhand(4) and West Bengal(0).

The value of output 'Number of Trials Completed (NTCOM)' projected to increase for the following state police units for them to be relatively efficient: Andhra Pradesh(61834 to ~82350), Arunachal Pradesh(130 to ~2960), Assam(21648 to ~52209), Goa(1367 to ~3454), HP(6008 to ~7925), J&K(12907 to ~18324), Jharkhand(27141 to ~43763), Karnataka(83802 to ~1046177), Maharashtra(104982 to ~181205), Manipur(97 to ~9635), Meghalaya(299 to ~ 5819), Odisha(841992 to~54271), Punjab(25020 to ~34784), Rajasthan(84863 to ~103639), , Sikkim(627 to ~717) , Telangana(55548 to ~75095), and Tripura(2329 to ~3303). The value of output 'Number of Trials Completed (NTCOM)' projected to remain unchanged for the following state police units for them to be relatively efficient: Bihar(48414), Chhattisgarh(44539), Gujarat(72557), Haryana(40741), Kerala(138840), MP(42051), Mizoram(2160), Nagaland(711), Tamil Nadu(178569), Uttar Pradesh(72847), Uttarakhand(4931) and West Bengal(38844).

Table 2 Projections of DMUs

DMU Name	TPE	CVPL	TPPL	TCI	NCEU	CSS-SLL	CSS-IPC	NPCON	NTCOM
Andhra Pradesh	1881.46	80.88	110.10	164218.00	11013.00	88613.10	123211.02	85.23	82349.83
Arunachal Pradesh	50.80	2.55	2.99	6229.00	343.53	8356.16	5204.81	0.55	2959.87

Assam	1275.77	46.64	55.09	126319.76	5706.00	133603.38	94532.48	8.98	52209.24
Bihar	4179.64	55.83	69.79	246905.00	2502.00	15070.00	109158.00	2.00	48414.00
Chhattisgarh	1657.12	147.85	218.83	63141.00	5284.00	244873.00	44477.00	6.00	44539.00
Goa	59.28	2.98	3.49	7269.00	400.88	9751.32	6073.82	0.65	3454.05
Gujarat	2514.60	87.44	119.54	142577.00	14439.00	301688.00	105833.00	28.00	72557.00
Haryana	2554.77	133.27	156.29	99154.00	8230.00	28056.00	44175.00	136.00	40741.00
Himachal Pradesh	359.14	85.26	197.54	16794.00	1494.57	5112.06	11704.90	13.50	7925.35
Jammu & Kashmir	837.54	244.50	569.58	34951.00	3261.94	47263.70	26935.72	15.62	18323.90
Jharkhand	1345.92	114.85	172.40	72135.00	5205.23	197762.78	54700.69	8.05	43762.57
Karnataka	2539.87	78.51	97.87	196686.00	14895.49	95499.86	138282.68	87.39	104616.95
Kerala	2382.72	119.80	140.21	292187.00	16114.00	391967.00	244145.00	26.00	138840.00
Madhya Pradesh	2734.44	88.86	119.86	289365.00	18691.00	89665.00	223867.00	145.00	142051.00
Maharashtra	3678.70	113.84	153.32	372578.20	24232.21	176814.45	286404.24	183.36	181204.77
Manipur	165.35	8.31	9.73	20277.00	1118.27	27201.47	16943.01	1.80	9635.13
Meghalaya	99.87	5.02	5.88	12247.00	675.42	16429.27	10233.32	1.09	5819.47
Mizoram	327.33	364.10	915.78	2857.00	1020.00	354.00	2056.00	0.00	2160.00
Nagaland	736.01	385.39	939.54	1819.00	1853.00	580.00	762.00	11.00	711.00
Odisha	1670.23	72.03	88.87	116262.00	8154.63	35083.03	78450.98	88.75	54270.46
Punjab	1761.79	159.83	264.88	64711.00	5590.57	118409.96	36031.79	54.22	34783.59
Rajasthan	2201.94	76.63	102.66	214141.00	13698.00	74105.51	161811.35	108.69	103639.02
Sikkim	107.33	118.93	299.09	950.00	334.49	181.92	683.39	0.00	717.37
Tamil Nadu	5486.08	145.51	164.08	280683.00	28147.00	253362.00	159284.00	64.00	178569.00
Telangana	1491.97	58.80	70.98	150388.00	9547.72	145621.74	117939.91	35.15	75094.63
Tripura	247.25	240.66	603.11	5843.00	888.43	5554.61	4664.82	0.35	3303.24
Uttar Pradesh	8917.25	64.82	78.14	284648.00	24941.00	2508223.00	147631.00	11.00	72847.00
Uttarakhand	955.14	141.81	181.91	11990.00	3021.00	87533.00	5411.00	4.00	4931.00
West Bengal	3085.88	57.05	71.53	262393.00	9186.00	22917.00	160214.00	0.00	38844.00

Source: Author's calculations.

3.2 Efficiency and Inefficiency of DMUs

State police units of Bihar, Chhattisgarh, Gujarat, Haryana, Kerala, Madhya Pradesh, Mizoram, Nagaland, Tamil Nadu, Uttar Pradesh Uttrakhand and West Bengal are considered efficient amongst the selected set of decision making units. While the state police units of Andhra Pradesh, Arunachal Pradesh, Assam, Goa, Himachal Pradesh, Jammu & Kashmir, Jharkhand, Karnataka, Maharashtra, Manipur, Meghalaya, Odisha, Punjab, Rajasthan, Sikkim, Telangana and Tripura have efficiency scores ranging between zero and 1(excluding 0 and 1) so they are termed as inefficient. The inefficiency of these state police units can be reduced by enhancing their outputs(Table 3).

This is the crux of the output-oriented model run for the analysis. It is worth mentioning that Himachal Pradesh, Karnataka, Odisha, Rajasthan, and Sikkim need to increase their outputs by a nominal percentage i.e., 4 per cent[(1-0.96)*100], 20 per cent, 6 per cent, 18 per cent and 13 per cent respectively. State police units of Andhra Pradesh, Jammu & Kashmir, Maharashtra, Punjab, Telangana and Tripura can enhance their efficiency by increasing their output i.e., crime clear ups by 25 per cent, 30 per cent, 24 per cent, 28 per cent, 26 per cent and 29 per cent respectively;

Table 3: Efficiencies of DMUs

S.No.	DMU Name	Objective Value	Efficient
1.	Andhra Pradesh	0.75	
2.	Arunachal Pradesh	0.38	

3.	Assam	0.51	
4.	Bihar	1	Yes
5.	Chhattisgarh	1	Yes
6.	Goa	0.43	
7.	Gujarat	1	Yes
8.	Haryana	1	Yes
9.	Himachal Pradesh	0.96	
10.	Jammu & Kashmir	0.70	
11.	Jharkhand	0.50	
12.	Karnataka	0.80	
13.	Kerala	1	Yes
14.	Madhya Pradesh	1	Yes
15.	Maharashtra	0.76	
16.	Manipur	0.03	
17.	Meghalaya	0.18	
18.	Mizoram	1	Yes
19.	Nagaland	1	Yes
20.	Odisha	0.94	
21.	Punjab	0.72	
22.	Rajasthan	0.82	
23.	Sikkim	0.87	
24.	Tamil Nadu	1	Yes
25.	Telangana	0.74	
26.	Tripura	0.71	
27.	Uttar Pradesh	1	Yes
28.	Uttarakhand	1	Yes
29.	West Bengal	1	Yes

Source: Author's calculations.

and state police units of Arunachal Pradesh, Assam, Goa, Jharkhand, Manipur and Meghalaya need a much higher percentage increase in outputs to be anywhere near being efficient. In total, our DEA assessment found out that 12 of the states' police units were efficient and the rest of the 17 state police units were inefficient as their efficiency ratings were less than 1.0.

it is vividly clear from Figure 1 signifying the distribution of State Police Units of India that the state police units of Andhra Pradesh, Assam, Himachal Pradesh, Jammu & Kashmir, Jharkhand, Karnataka, Maharashtra, Odisha, Punjab, Rajasthan, Sikkim, Telangana and Tripura need to make much lesser efforts to overcome their inefficiencies. Whereas state police units of Arunachal Pradesh, Goa, Manipur and Meghalaya need to make much greater efforts to reach the efficiency level of 1.

The focus of this study is to measure the relative efficiency of the state police units of India using a selected set of inputs and outputs as is clear from the above discussion. The analysis till now and further on in this paper has derived results based on relative efficiency scores, projections and slack values only. A major cause of concern after analyzing the relative efficiency scores of the state police units would be regarding the identification of reasons behind the inefficiencies of some of the units as compared to the other units which have turned out to be efficient in the analysis.

Once the reasons for inefficiencies, rather relative inefficiencies are identified, we shall be more clearly able to lead to improvements at the level where indicated- like the operational level, financial level, technological level etc.

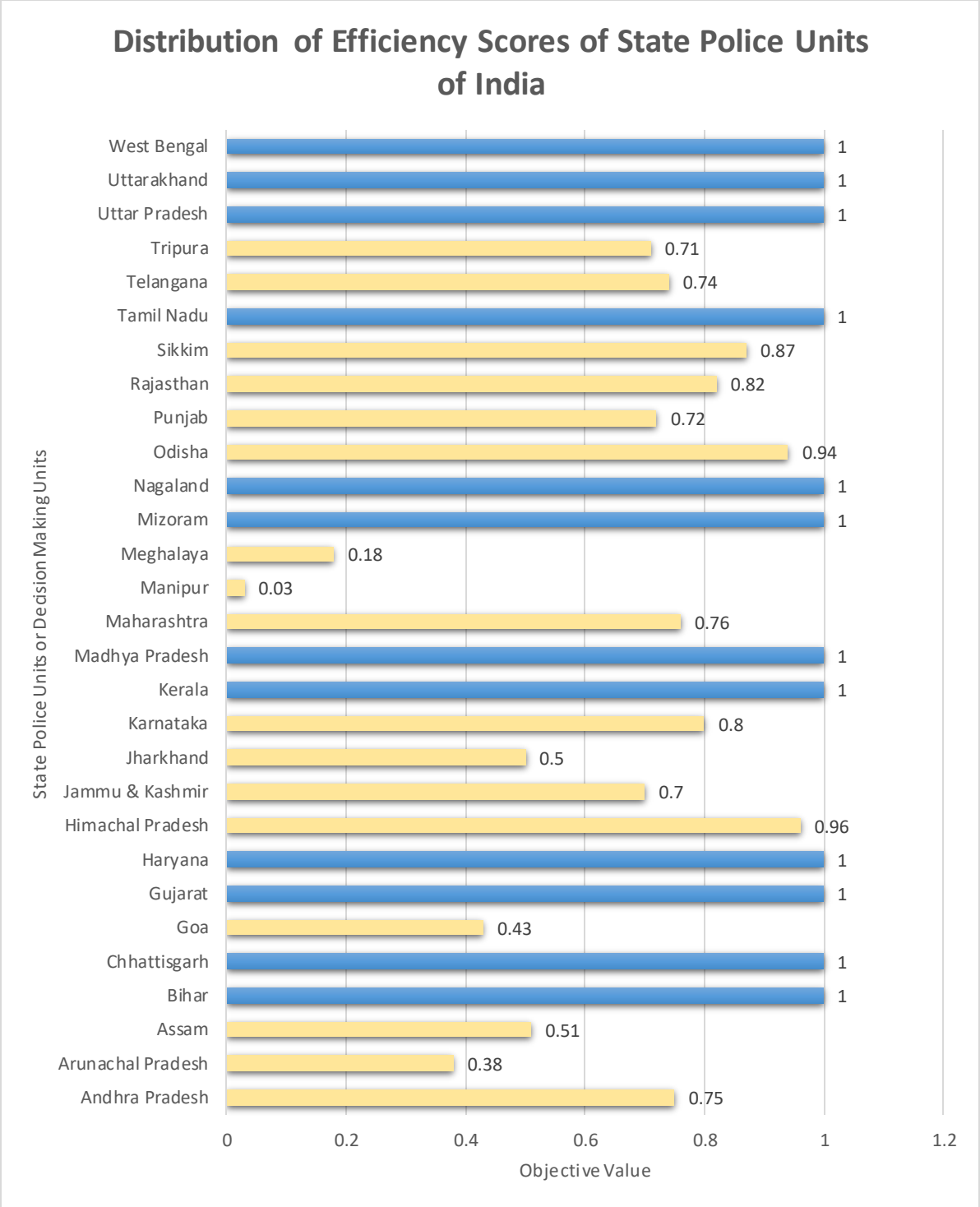


Figure 1: Distribution of Efficiency Scores of State Police Units of India

3.3 Lambdas of DMUs

To investigate returns to scale, the sum of lambda values of each DMU were calculated in order to determine the type of scale efficiency of the state police units. If the value of sum of all lambdas turned out to be greater than 1, there are increasing returns to scale, if the sum of all lambdas is less than one, then there is decreasing returns to scale and if the sum of lambdas is equal to 1, there are constant returns to scale(Cooper et al.,2000).

Table 4 :Values of Lambdas of DMUs for the State Police Units

DMU Name	Bihar	Chhattisgarh	Gujarat	Haryana	Kerala	Madhya Pradesh	Mizoram	Nagaland	Tamil Nadu	Uttar Pradesh	Uttarakhand	West Bengal
Andhra Pradesh	0	0.16	0	0.09	0	0.50	0	0	0.005	0	0	0
Arunachal Pradesh	0	0	0	0	0.02	0	0	0	0	0	0	0
Assam	0.11	0	0	0	0.34	0	0	0	0	0	0	0
Bihar	1	0	0	0	0	0	0	0	0	0	0	0
Chhattisgarh	0	1	0	0	0	0	0	0	0	0	0	0
Goa	0	0	0	0	0.02	0	0	0	0	0	0	0
Gujarat	0	0	1	0	0	0	0	0	0	0	0	0
Haryana	0	0	0	1	0	0	0	0	0	0	0	0
Himachal Pradesh	0	0	0	0.04	0	0.04	0	0.20	0	0	0	0
Jammu & Kashmir	0	0.11	0	0	0.04	0.05	0	0.57	0	0	0	0
Jharkhand	0	0.65	0	0	0.10	0.01	0	0.02	0	0	0	0
Karnataka	0	0	0	0.06	0	0.46	0	0	0.21	0	0	0
Kerala	0	0	0	0	1	0	0	0	0	0	0	0
Madhya Pradesh	0	0	0	0	0	1	0	0	0	0	0	0
Maharashtra	0	0	0	0	0	1.26	0	0	0	0.03	0	0
Manipur	0	0	0	0	0.07	0	0	0	0	0	0	0
Meghalaya	0	0	0	0	0.04	0	0	0	0	0	0	0
Mizoram	0	0	0	0	0	0	1	0	0	0	0	0
Nagaland	0	0	0	0	0	0	0	1	0	0	0	0
Odisha	0	0	0	0.35	0	0.28	0	0	0	0	0	0
Punjab	0	0.44	0	0.37	0	0	0	0.12	0	0	0	0
Rajasthan	0.02	0.04	0	0.06	0	0.69	0	0	0	0	0	0
Sikkim	0	0.00	0	0	0	0	0.33	0	0	0	0	0
Tamil Nadu	0	0	0	0	0	0	0	0	1	0	0	0
Telangana	0	0	0	0	0.29	0.16	0	0	0.06	0	0	0
Tripura	0	0	0	0	0.01	0	0.66	0	0	0	0	0
Uttar Pradesh	0	0	0	0	0	0	0	0	0	1	0	0
Uttarakhand	0	0	0	0	0	0	0	0	0	0	1	0
West Bengal	0	0	0	0	0	0	0	0	0	0	0	1

Source: Author's calculations.

From Table 4, the only DMU with sum of lambdas > 1 is Maharashtra indicating it has increasing returns to scale. Bihar, Chhattisgarh, Gujarat, Haryana, Kerela, Madhya Pradesh, Mizoram, Nagaland, Tamil Nadu, Uttar Pradesh, Uttrakhand and West Bengal have value = 1 implying Constant Returns to Scale; the lambda values of Andhra Pradesh, Assam, Bihar, Goa, Himachal Pradesh, Jammu & Kashmir, Jharkhand, Karnataka, Manipur, Meghalaya, Odisha, Punjab, Rajasthan, Sikkim, Telangana, Tripura and Uttar Pradesh have value < 1 implying Decreasing Returns to Scale.

3.3 Peer Group of DMUs/ Peer References:

So far as peer references are concerned, the Table 5 indicates clearly how frequently each efficient DMU was used to have comparisons of efficient peer for inefficient DMUs. The state police unit of Andhra Pradesh has Chhattisgarh, Haryana, Madhya Pradesh and Tamil Nadu as its peer group which simply implies that Andhra Pradesh can emulate the peer group to reach their relatively efficient peer group members.

Table 5: Peer Group of DMUs/ Peer References of DMUs

DMU Name	Peer Group
Andhra Pradesh	Chhattisgarh, Haryana, Madhya Pradesh, Tamil Nadu.
Arunachal Pradesh	Kerala.
Assam	Bihar, Kerala.
Bihar	Bihar.
Chhattisgarh.	Chhattisgarh.
Goa	Kerala.
Gujarat	Gujarat.
Haryana	Haryana.
Himachal Pradesh	Haryana, Madhya Pradesh, Nagaland.
Jammu & Kashmir	Chhattisgarh, Kerala, Madhya Pradesh, Nagaland.
Jharkhand	Chhattisgarh, Kerala, Madhya Pradesh, Nagaland.
Karnataka	Haryana, Madhya Pradesh, Tamil Nadu.
Kerala	Kerala.
Madhya Pradesh	Madhya Pradesh.
Maharashtra	Madhya Pradesh, Uttar Pradesh.
Manipur	Kerala.
Meghalaya	Kerala.
Mizoram	Mizoram.
Nagaland	Nagaland.
Odisha	Haryana, Madhya Pradesh.
Punjab	Chhattisgarh, Haryana, Nagaland.
Rajasthan	Bihar, Chhattisgarh, Haryana, Madhya Pradesh.
Sikkim	Chhattisgarh, Mizoram.
Tamil Nadu	Tamil Nadu.
Telangana	Kerala, Madhya Pradesh, Tamil Nadu.
Tripura	Kerala, Mizoram.
Uttar Pradesh	Uttar Pradesh.
Uttarakhand	Uttarakhand.
West Bengal	West Bengal.

Source: Author's calculations.

The good performance of a state police unit is hereby identified as per the number of times efficient DMUs appeared in the reference set (information culled out from Table 6). The most frequent efficient peers were found to be: Madhya Pradesh & Kerala(both appearing 10 times as efficient peer); followed by Chhattisgarh & Haryana(occurring 7 times as efficient peer); followed by Tamil Nadu(4), Bihar(3), Mizoram(2), Meghalaya(2), Uttar Pradesh(2), Mizoram(1), West Bengal(1) and Nagaland(1).

The method proposed by Chen(1997) and Chen & Yeh(1998) has been followed to discriminate the two efficient State Police Units who have used the frequency in the 'Reference set' to discriminate the state police units. There is a direct relationship as portrayed in the literature between the frequency with which an efficient state police unit shows up in the reference set of inefficient state police units and the robustness of the state police unit. It implies that the state police unit which appears more frequently in the peer group is likely to be more efficient with respect to a larger number of factors or higher the frequency, higher the robustness. On the basis of the above linkage, the efficient state police units have been categorised into two broad categories: Highly Robust State Police Units and Marginally Robust State Police Units. The former includes State Police Units of Madhya Pradesh(which occurs 10 times in frequency table) and Kerala(which occurs 10 times in the frequency table as well; and the latter includes Tamil Nadu(frequency 4), Bihar(frequency 3), Mizoram, Meghalaya & Uttar Pradesh(frequency 2 each), Mizoram, West Bengal and Nagaland(one times each). The reference set (their frequencies counted) are given in the table shown below:

Table 6 : Discrimination of Efficient State Police Units from frequency of appearing in reference set.

Highly Robust State Police Units	Marginally Robust State Police Units
Madhya Pradesh(10)	Tamil Nadu(4)
Kerala(10)	Bihar(3)
	Mizoram, Meghalaya, Uttar Pradesh(2 times each)
	Mizoram, West Bengal and Nagaland(one times each)
Note: Figures in parentheses are frequency count.	

Source: Author's calculations.

Besides the above discrimination, an attempt was made to discriminate the inefficient state police units as well for which the quartile values of efficiency scores were used. In the 'most inefficient' category, those state police units have been included which attained the efficiency score below the value of the first quartile(>Q1= 0.4650 from Col. 3 of Table 8); in the ' below average category, those state police units have been included which attained the efficiency.

Table 7: Classification of Inefficient State Police Units

Most Inefficient	Below Average	Above Average	Marginally Inefficient
Arunachal Pradesh	Assam	Himachal Pradesh	Andhra Pradesh
Goa	Jammu & Kashmir	Odisha	Karnataka
Meghalaya	Jharkhand	Rajasthan	Maharashtra
Manipur	Punjab	Sikkim	Telangana
	Tripura		

Source: Author's calculations.

score between the value of the first quartile and the median(Q1= 0.4650 and Median =0.7200); in the ' above average' category, those state police units have been included which attained the efficiency score between the value of the median and the third Quartile(median =0.7200 and Q3=0.8100); and in the 'Marginally inefficient' category are included those state police units which attained the efficiency score <third Quartile (Q3=0.8100) but <1.

Table 8: Table showing the Statistical measures for the State Police Units

Statistical measure	All State Police Units	Efficient State Police Units	Inefficient State Police Units
N	29	12	17
Mean	0.7862	1.0000	0.6353
Std. Deviation	0.26872	.00000	0.26056
Minimum	0.03	1.00	0.03
Q1	0.7050	1.00	0.4650
Median	0.8700	1.0000	0.7200
Q3	1.000	1.0000	0.8100
Maximum	1.00	1.00	0.96
Avg. Overall Technical Inefficiency	21.38	0	36.47
Interval	(0.51748;1.05492)	(1.0000;1.0000)	(0.3714, 0.89586)

Source: Author's calculations.

3.4 Slacks of DMUs

As far as the slacks is concerned, they exist only for those state police units under the Data Envelopment Analysis, which are identified as inefficient. in a particular run of the software. The slacks basically provide the information related to the variables needing improvement for the decision-making unit i.e., the state police units in the current research work to approach the status of an efficient one.

The table regarding slacks of inputs and outputs gives an outstanding and complete result of how to improve the efficiency of the DMU in concern. The slack values for the efficient state police units turn out to be zero, indicating no change in the outputs. In the 'marginally inefficient, category , as per the slack values calculated, Andhra Pradesh, has to increase the number of SLL cases charge-sheeted to 72826 and increase the number of IPC cases charge-sheeted to 876; Karnataka is suggested to increase output of number of SLL cases charge-sheeted to 64140 and the number of IPC cases charge-sheeted to 16401 , Maharashtra is suggested to let its number of SLL cases charge-sheeted remain unchanged but increase the number of IPC cases charge-sheeted to 56225; and Telangana is supposed to increase the number of SLL cases charge-sheeted to 130783 and the number of IPC cases charge-sheeted to 94 in order to be termed as efficient. In the other extreme category of 'most inefficient' state police units, Arunachal Pradesh has been suggested to increase number of SLL cases charge-sheeted to 7947 and the number of IPC cases charge-sheeted have been suggested to remain unchanged; Goa has been suggested to increase number of SLL cases charge-sheeted to 6416 and the number of IPC cases charge-sheeted have been advised to remain unchanged; Manipur has been advised to increase the number of SLL cases charge-sheeted to 1287 and number of IPC cases charge-sheeted to remain unchanged; and Meghalaya has been suggested to increase number of SLL cases charge-sheeted to 15493 and the number of IPC cases charge-sheeted have been advised to be unchanged. We can draw similar conclusions for the rest of the State Police Units as well. There is an option of reducing the inputs in the model i.e., total police expenditure and number of civil police per lakh of population could have been suggested to be reduced by 798.89 and 17 respectively. But since we have used the output-oriented model for our analysis, the DMU rather should go in for increase in output with same level of inputs to improve efficiency rather than decreasing the inputs for same level of output.

Table 9: Value of Slacks of DMUs

DMU Name	TPE	CVPL	TPPL	TCI	NCEU	CSS-SLL	CSS-IPC	NPCON	NTCOM
Andhra Pradesh	798.89	17.00	0	0	0	72826.08	876.90	0	0
Arunachal Pradesh	527.30	565.33	877.46	0	825.47	7947.27	0	0.55	2616.92
Assam	0	41.51	108.72	90037.24	0	129768.56	0	8.98	10111.83
Bihar	0	0	0	0	0	0	0	0	0
Chhattisgarh	0	0	0	0	0	0	0	0	0
Goa	206.95	264.70	351.13	0	564.12	6416.40	0	0.65	283.79
Gujarat	0	0	0	0	0	0	0	0	0

Haryana	0	0	0	0	0	0.00	0	0	0
Himachal Pradesh	315.99	46.40	0	0	933.43	2016.36	0	0	1688.27
Jammu & Kashmir	2366.64	122.51	0	0	5648.06	45111.46	0	0	0
Jharkhand	1209.38	14.12	0	0	3053.77	188290.05	0	0	0
Karnataka	0	27.53	22.60	0	6099.51	64140.50	16401.85	0	0
Kerala	0	0	0	0	0	0	0	0	0
Madhya Pradesh	0	0	0	0	0	0	0	0	0
Maharashtra	2916.89	25.41	0	48079.80	1696.79	0	56225.44	0	42719.15
Manipur	535.61	481.15	974.45	0	1044.73	18287.97	0	1.80	6062.36
Meghalaya	446.31	252.21	452.01	0	590.58	15493.56	0	1.09	4202.26
Mizoram	0	0	0	0	0	0	0	0	0
Nagaland	0	0	0	0	0	0	0	0	0
Odisha	681.19	0	30.74	0	2781.37	13336.15	4456.82	0	9367.32
Punjab	2577.34	49.43	0	0	863.43	90248.04	3421.13	0	0
Rajasthan	1409.14	39.18	31.52	0	0	0	40125.91	0	0
Sikkim	207.29	223.41	459.36	0	401.51	0	229.17	0.00	0
Tamil Nadu	0	0	0	0	0	0	0	0	0
Telangana	0	57.31	66.39	0	1450.28	130783.42	94.55	0	0
Tripura	372.28	30.67	34.30	0	1610.57	5331.93	0	0.35	0
Uttar Pradesh	0	0	0	0	0	0	0	0	0
Uttarakhand	0	0	0	0	0	0	0	0	0
West Bengal	0	0	0	0	0	0	0	0	0

Source: Author's calculations.

Also, the other DMUs could analysed be using this set of slack values to identify the various outputs that need to be changed to enhance relative inefficiency of the state police units concerned. The main thing to be observed herein is the non-zero slack values of output variables whose change in value from the original indicates the level of adjustment needed to augment that particular output for projecting them onto the efficiency frontier. On the whole, 14 out of the 29 state police units need to improve efficiency by increasing the number of IPC cases charge-sheeted, 8 out of the 29 state police units need to increase the number of SLL cases charge sheeted, 6 of the 29 states need to increase the number of persons convicted to enhance their efficiencies; and 8 out of 29 state police units need to increase the number of trials completed 00 to enhance the efficiency. 6 of the 29 state police units would actually have to increase efficiency by increasing three of the outputs simultaneously i.e., CSS-IPL, CSS-SLL and NTCOM.

4.0 Conclusion

The study has been able to bring to light the relative efficiency among the 29 state police units and very unlikely states like Bihar, Uttar Pradesh, Chhattisgarh have been found to be the relatively efficient ones and Manipur has come out to be in need of major transformation to come up to the level of its relatively efficient peer state police unit of Kerala. The phenomenon of peer efficient units in DEA is a very upbeat one so far as police performance is concerned since the concerned state police units thus are able to make improvements in their performance levels by following the best practices of the efficient peer. Like the best practices of Chhattisgarh, Haryana, Madhya Pradesh and Tamil Nadu can be imbibed by the Andhra Pradesh state police unit to reach the efficient position. Also, the identification of the amount of change needed in various inputs and outputs to have efficient performance is also of utmost significance to the various state police units as the DMU will be able to clearly work on better levels of efficiency by specific efforts needed to be made for this kind of improvement.

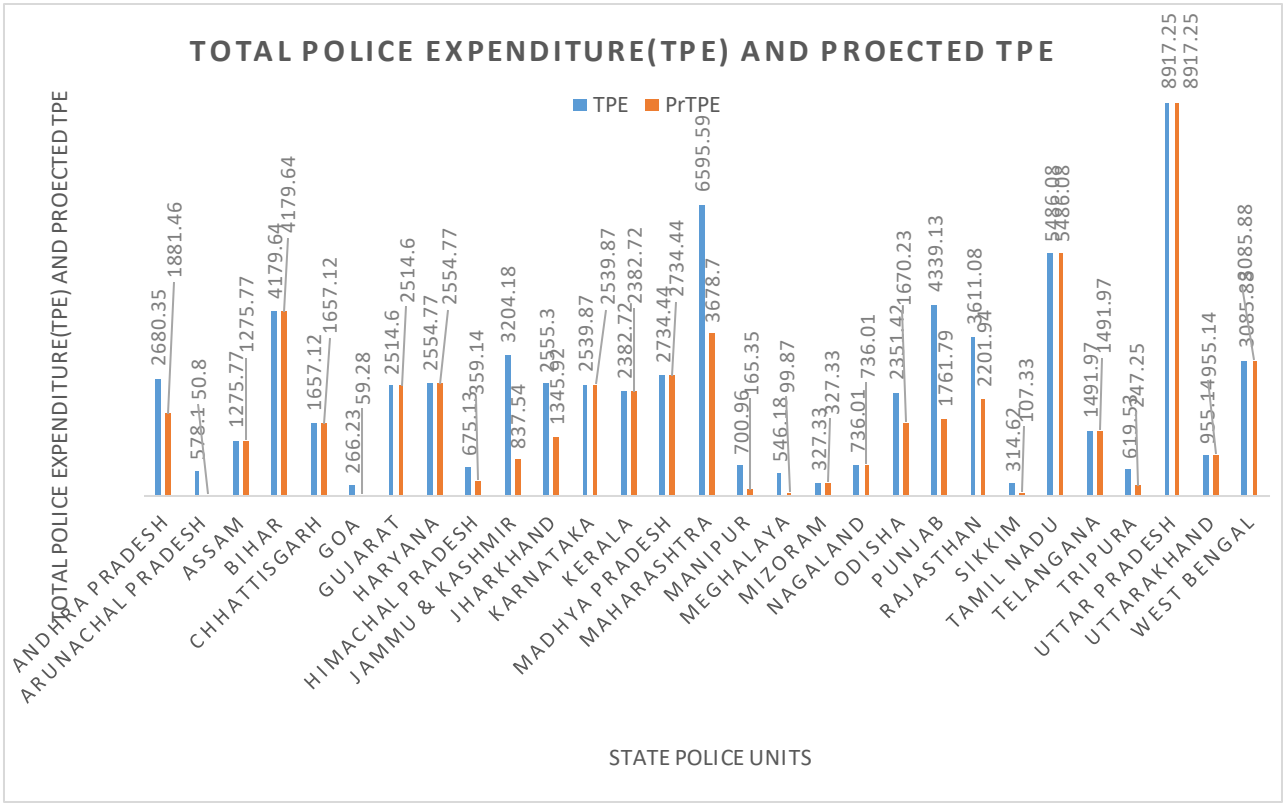
5.0 Limitations and Future Scope of the Study

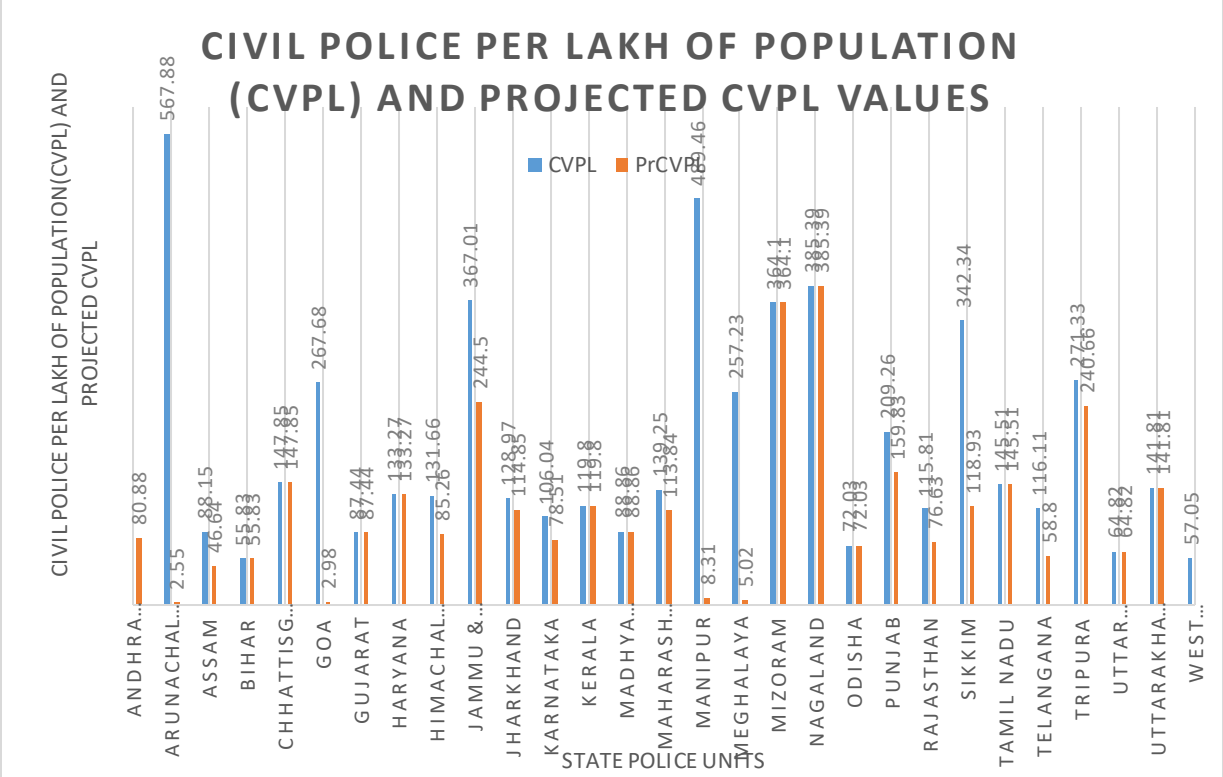
Since the method used to analyse the efficiency of state police units in India is a non parametric technique which measures only relative efficiency and not absolute efficiency, wherein the units are being compared to the peers in the group concerned rather than any external standard, it may be a considered a limitation in itself. All said and done, the study does meet its aim of analyzing efficiency scores of state police units using data envelopment analysis, but still a lot needs to be done beyond identification of inefficient units amongst peer group. A very logically important issue pertaining to the further research is to focus upon finding the reasons of inefficiency in the various units wherein analysis needs to be done regarding not only to identify the core area of inefficiency like operational inefficiency, technical inefficiency, economic inefficiency etc. this would certainly lead to improvements in the state police units which have been identified as inefficient in this study. With the appropriate identification of reasons of inefficiency, the policy regarding the working of the state police units could be prepared with proper focussed interventions.

A deeper look into the working and responsibilities of the police units of Union Territories of India needs to be provided for in the future wherein the efficiencies of these units may also be covered under the ambit of future research. This would certainly help in emulating any 'best practices' of the U.T. police units as well. Also there is ample scope for researchers to use statistical measures like regression etc alongside to further strengthen the results so obtained through DEA technique.

6.0 Appendix:

The following charts are indicating the actual and projected values of the inputs chosen, and a closer analysis clearly tells that the inefficient state police units need to change the inputs to have more efficiency.

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CIVIL POLICE PER LAKH OF POPULATION(CVPL) AND PROJECTED CVPL
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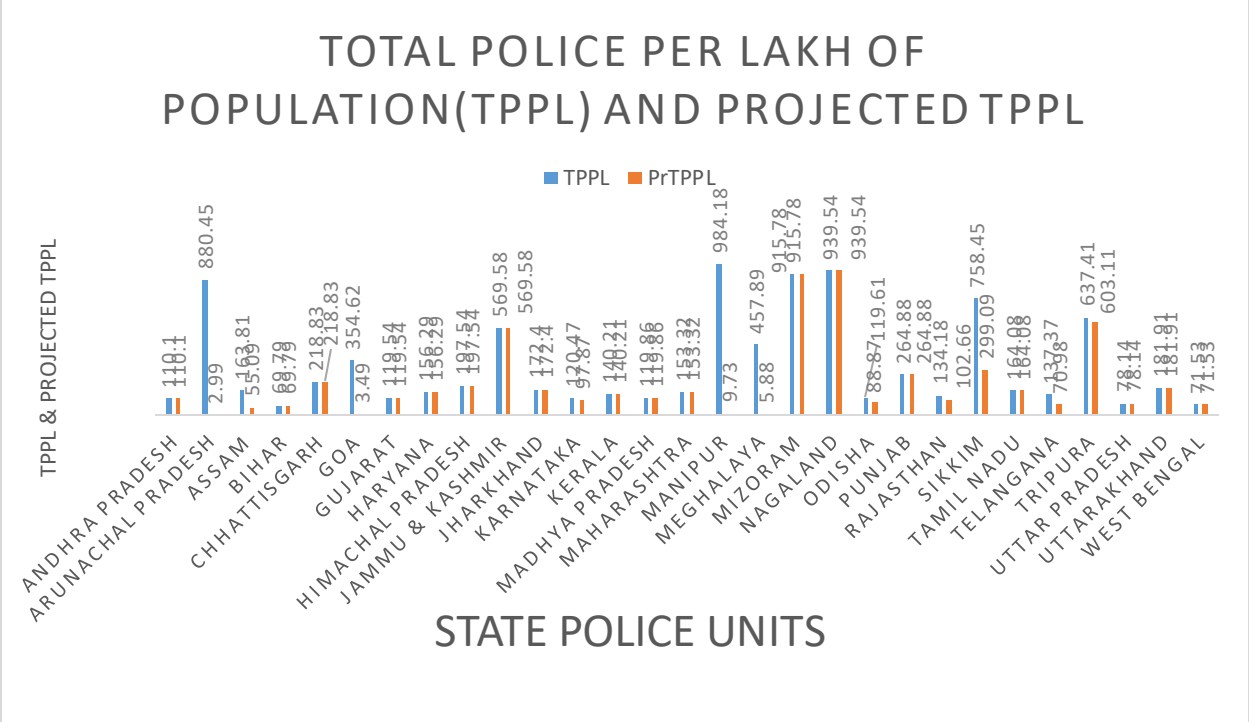
TOTAL POLICE PER LAKH OF POPULATION(TPPL) AND PROJECTED TPPL
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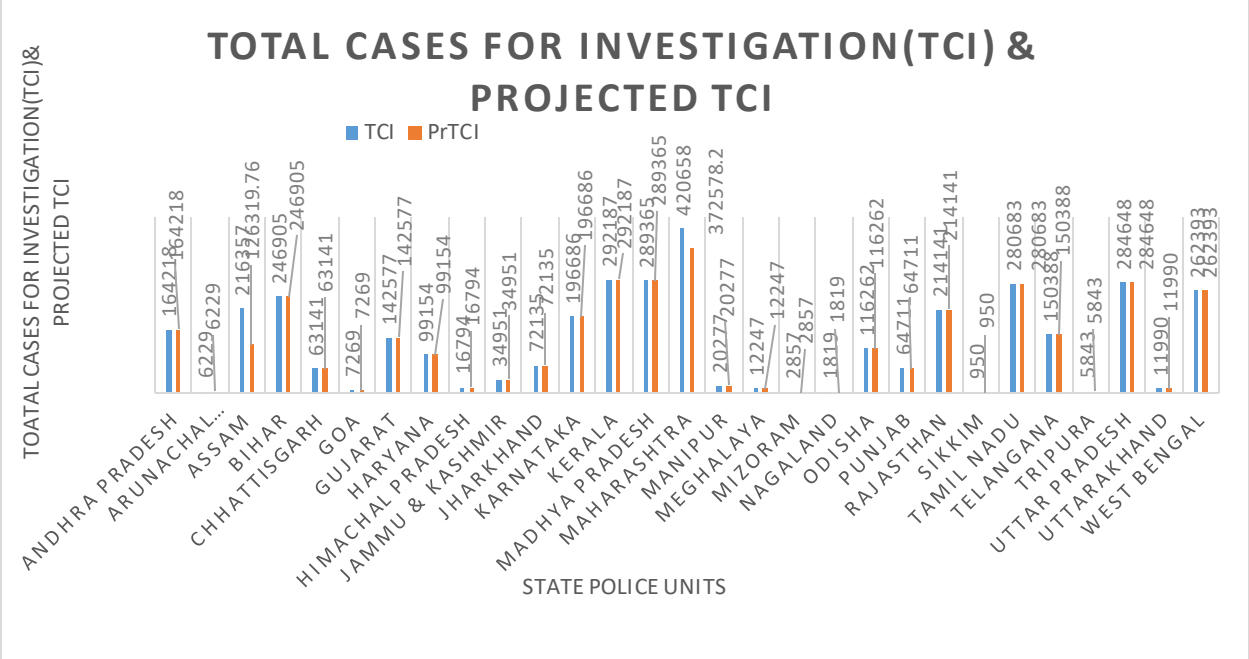
STATE POLICE UNITS
ANDHRA PRADESH
ARUNACHAL PRADESH
ASSAM
BIHAR
CHHATTISGARH
GOA
GUJARAT
HARYANA
HIMACHAL PRADESH
JAMMU & KASHMIR
JHARKHAND
KARNATAKA
KERALA
MADHYA PRADESH
MAHARASHTRA
MANIPUR
MEGHALAYA
MIZORAM
NAGALAND
ODISHA
PUNJAB
RAJASTHAN
SIKKIM
TAMIL NADU
TELANGANA
TRIPURA
UTTAR PRADESH
UTTARAKHAND
WEST BENGAL


TOTAL CASES FOR INVESTIGATION(TCI) & PROJECTED TCI
TCI
PrTCI
TOATAL CASES FOR INVESTIGATION(TCI)& PROJECTED TCI
STATE POLICE UNITS
ANDHRA PRADESH
ARUNACHAL...
ASSAM
BIHAR
CHHATTISGARH
GOA
GUJARAT
HARYANA
HIMACHAL PRADESH
JAMMU & KASHMIR
JHARKHAND
KARNATAKA
KERALA
MADHYA PRADESH
MAHARASHTRA
MANIPUR
MEGHALAYA
MIZORAM
NAGALAND
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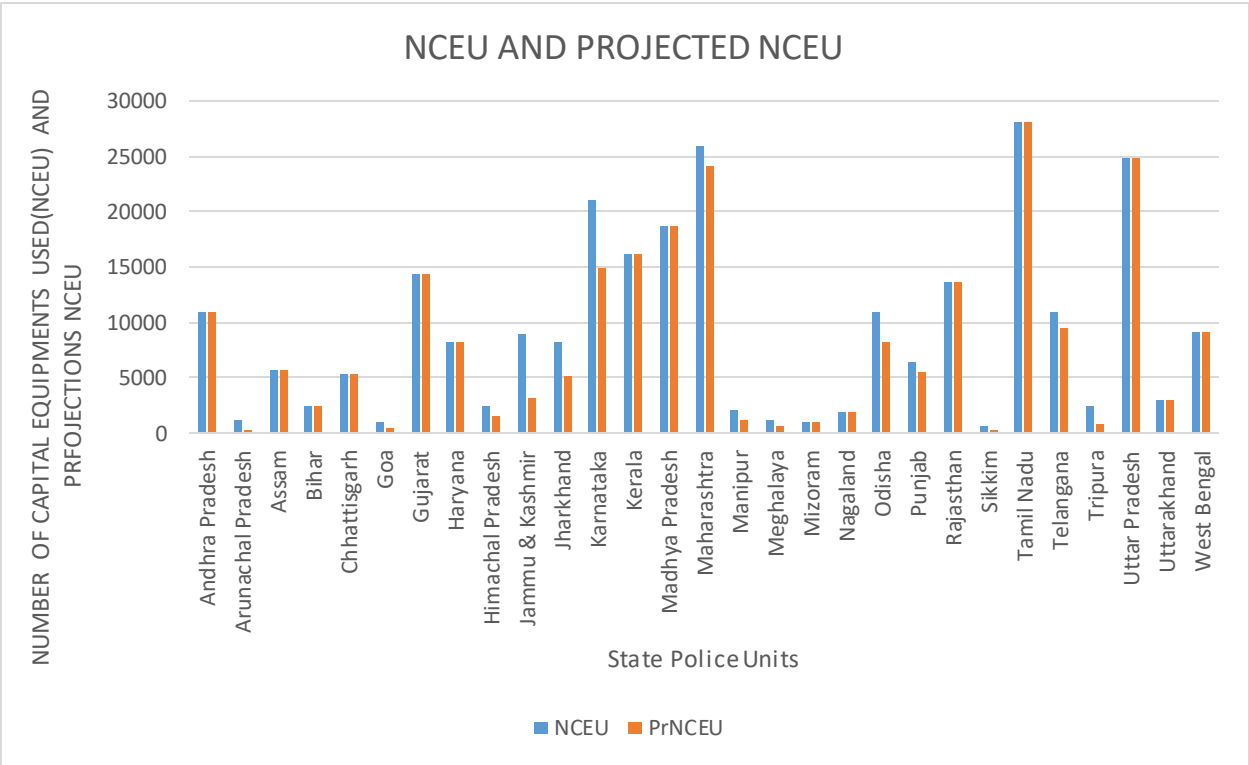
UTTAR PRADESH
UTTARAKHAND
WEST BENGAL


NCEU AND PROJECTED NCEU
NUMBER OF CAPITAL EQUIPMENTS USED(NCEU) AND PRFOJECTIONS NCEU
30000
25000
20000
15000
10000
5000
0
Andhra Pradesh
Arunachal Pradesh
Assam
Bihar
Chhattisgarh
Goa
Gujarat
Haryana
Himachal Pradesh
Jammu & Kashmir
Jharkhand
Karnataka
Kerala
Madhya Pradesh
Maharashtra
Manipur
Meghalaya
Mizoram
Nagaland
Odisha
Punjab
Rajasthan
Sikkim
Tamil Nadu
Telangana
Tripura
Uttar Pradesh
Uttarakhand
West Bengal
State Police Units
NCEU
PrNCEU

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