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EFFICIENCY DIFFERENCES AMONG LAW ENFORCING UNITS IN PUNJAB, PAKISTAN: Application of Data Envelopment Analysis

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In recent years, all over the world, governments are much concerned about setting targets in order to achieve better efficiency of public goods. In Pakistan, the government of Punjab is also spending a major chunk of its yearly budget on the Punjab Police so that law and order situation can be controlled. The Punjab police is working in the province since 1861;now it is constituted under the Police Ordinance 2002. The main priority of police service is to provide security to its citizens. To check efficiency of the law enforcing agencies, particularly the police force. Unfortunately no study exist in this area for the province of Punjab, Pakistan. In the present study, efficiency of the Punjab police is evaluated at district level by incorporating multiple inputs and outputs with six years data set (from 2007 to 2012). Data Envelopment Analysis (DEA) is used to obtain efficiency of the Punjab Police at district level. In addition, the second stage DEA has provided district level targets and issues. The results of this study would help the researchers, policy makers, planners and the Government of Pakistan to device better police strategies, identify weak areas and improve performance of the police and set targets for inefficient units.

I. Introduction

Pakistan is suffering with a growing law and order situation, over two decades. A significant increase in criminal activities along with security outbreak has become a routine matter in rural and urban Pakistan. According to the national criminal database, 19,53,209 cases of heinous crimes were reported only in the province of Punjab, during the last five years. This shows an alarming increase over the past few years. The social fabric of our society is being crippled by the diminishing economic performance of Pakistan. These circumstances are leading towards a chaotic society and an economic adversity. Safety and security are now growing concerns for all the nationals of Pakistan.

To ensure public safety, some law enforcement agencies have been operating in Pakistan. Police is one of the key institutions to assure security and safety of its

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citizens. The age which the Pakistan is now passing through, has outstripped the types of policing practices; specifically in the province of Punjab [Rashid (2012)]. Evaluation of performance of the police institutions, as well as in individual officers remains a contentious issue [Kelling (1992)]. Police officers perform a variety of tasks which are hard to assess due to many barriers, like conflict of interest and pressure of politicians. Under the 18th amendment, law and order have been delegated from the federal to the provincial powers. Being the most populous province, Punjab is spending its biggest chunk of allocated budget (PKR. 70.50 billion) on law enforcing agencies [Anjum (2013)].

With 43 metropolitan cities, the province of Punjab is on top of the list for maintaining law and order situation and facing the terrorist attacks as crime is always newsworthy to put the ruling party on a defensive track. Especially in the large metropolitan cities, it attracts the public attention which demands a better performance from the police. The Punjab police is the world's second largest police organization with more than 1,80,000 working professionals. Every year, the police department becomes more burdened due to annual increase in salaries and other benefits, purchase of modern vehicles, arms and equipments, etc. In this context, effective policing plays a crucial role in making the society secured and crime free. The governments always try to help the police in order to attain efficiency and perform better. Resultantly, police is always at the forefront to take measures to reduce crime from the society, protect its citizens and maintain law and order situation. When the government spends tax payers' money, it is at right to expect better performance from the police with improvement in their efficiency. The main duty of the police force is to protect individual's rights along with safety, as the police task covers a wide range of activities which is hard to mention or evaluate, point by point. In police service, efficiency is to minimize the crime rate in order to justify the money spent. Therefore, there is a need to assess the working capability of the Punjab police through some quantitative analysis.

1. The Objectives of the Study

Following are the key research objectives which need to be discussed:

a) To calculate technical efficiency of the Punjab police in Pakistan, using quantitative tools.

b) To make district-wise recommendations for the Punjab province on the basis of empirical findings of this research.

To the best of the information available; so far, no study has been conducted on this issue, therefore, it will not only help the Punjab police to devise new strate-

gies to improve their working capability, but will also pave new ways for upcoming research. This is a high time for the Punjab police to opt new and innovative ways in order to attain efficiency and maintain law and order. This study will facilitate our police to identify weak areas through comparative analysis.

2. The Punjab Police and the Province of Punjab

The department of Punjab Police was established as a separate entity under the British rule in 1861. It played a vital role in administering the refugee crisis during their migration from India to Pakistan, in 1947 and 1948. For the first time, police functions were introduced by the government of India in 1861 through a bill which was later passed as a law (Act V of 1861). This bill was implemented as the Police Act of 1861. Besides this, organizational and operational variations were also introduced in 1934. This law/act was replaced by the Police Order in 2002 and through this new law the public accountability in the form of public safety commission was introduced at the district, provincial and national level. The legal framework experienced important structural modifications as a result of devolution of power plan during 2001 to 2006 [Abbas (2011)]. Now, the Punjab police is constituted under the Police Ordinance 2002 and is working under the Police Rules of 1934.

The Punjab Police is a law enforcing body which functions under the provincial government and is headed by the Inspector General Punjab. All cadres from the Additional Superintendent Police (ASP) to the Inspector General Punjab (IGP) are recruited at the federal level through the Federal Public Service Commission, whereas, rest of the junior officers are recruited at the provincial level.

Punjab is the most populous province of Pakistan and has more than 80 million population in an area of 2,05,344 square kilometers [Ali (2015)]. Consequently, Punjab requires better law and order situation since the Punjab police is the only operating police force throughout 36 districts with 750 police stations. Police ratio to population is almost same throughout the province, though the crime rate differs from one area to another.

3. Tools for Comparative Performance

In a comparative performance measurement, the unit is considered as an entity, and if the entities are same, they can be compared. Therefore logically we are able to compare the local police units or metropolitan forces.

The cross sectional data is used to perform efficiency analysis of the Punjab Police through the Data Envelopment Analysis (DEA). DEA is a non-parametric linear programming system used to assess the different decision making units, specifically in operations research and economics for the estimation of production

frontiers. It is used to measure productivity efficiency of Decision Making Units (DMUs) on an empirical basis. Non-parametric methods have the benefit of not assuming a particular functional shape for the frontier; though they do not deliver a general relationship (equation) concerning output and input. There are also parametric approaches which help to estimate the production frontiers.

The frame has been altered since multi-input and multi-output production functions have been applied in many establishments. DEA progresses a function whose system is determined by the most efficient producers. This method varies from the Ordinary Least Squares (OLS) statistical method which centers assessments relative to an average producer. Like Stochastic Frontier Analysis (SFA), DEA recognizes a frontier on which the relative performance of all utilities in the sample can be compared: DEA benchmark only firms against the best producers. The DEA framework has conventionally been applied with implicit assumption that efficient production provides an increase in outputs with increased inputs.

After the introduction (Section I), literature review is presented in Section II. The methodology is developed in Section III, while the data is given in Section IV. Empirical results are provided in Section V, and finally, the paper is concluded in Section VI.

II. Literature Review

The DEA attributed to Farrell (1957) was used for the first time to assess the efficiency of law enforcement during the mid-90's. Efficiency analysis is a relatively dynamic concept which can be incorporated in different ways. Firstly, allocative efficiency and technical efficiency were measured by Farrell (1957) using non-parametric technique. However, it was the mid-90's when this technique was utilized for the very first time for law enforcement, but afterward it became one of the important operational research techniques to compare efficiencies.

Thanassoulis (1995) assesses the relative efficiency through output oriented CCR model for the analysis of forty-one police forces in England and Wales. Thanassoulis (1995) uses four inputs, including a number of police officers employed at each force, the number of violent crimes, burglaries and other crimes with three outputs, including the number of clear-ups of violent crimes, burglaries, and other crimes in the DEA model. The primary analysis of crime, crime clear-up and manpower data was taken to lead on to an initial valuation of performance. The assessment was then advanced so that not only more confidence could be added in the results obtained but also performance in definite areas, such as, manning levels as distinct from crime clear ups could be gained.

Carrington et al. (1997) evaluate the efficiency of 25 districts with 167 police stations in New South Wales, in the year 1994 and 1995. Three inputs (sworn officers, civilian employees, and police cars) are used with five outputs (offenses, ar-

rests, summons, automobile accidents and vehicle travel distances). The New South Wales police was found on average and could reduce 13.5 per cent of input usage by better management; and concludes that location or socioeconomic factors do not contribute to police efficiency.

Drake and Simper (2004) estimate the cost efficiency of police forces in England and Wales and perform the cost efficiency analysis by using DEA. Total staff cost, transport cost and capital and other costs to proxy for labor, transport and capital-input are considered as inputs. They incorporate managerial efficiency outcomes, response outcomes, and proactive outcomes. The number of complaints per officer and average number of days lost per officer are used as outcomes for managerial efficiency. The number of crimes solved and the number of emergency calls to stations answered within a target time are the response outcomes. Only ten police forces are found skilled and technically efficient in England and Wales.

Goltz (2006) takes the cross sectional data of one hundred and thirteen police stations from the state of Florida. This study categorizes the variables in three different ways which includes exogenous environmental constraint, endogenous design structure variables and endogenous performance variables. In this analysis, environmental constraints are applied to assess the direct effect on police performance. Additionally, the credit to use structural equation modeling along with the DEA for the first time was earned. The positive effects of environmental, social economic disparity on police resources and police efficiency was found.

Verma and Gavirneni (2006) develop a framework to compare the relative efficiency mechanism through four inputs, (total expenditures, number of police officers, number of investigating officers and total number of investigated cases) with four outputs (number of persons arrested, number of persons charge sheeted, number of persons convicted and number of trials completed). They find that DEA can be helpful in determining and comparison of relative efficiency of a police department which was also applicable to the criminal justice system.

Gorman and Ruggiero (2008) evaluate the efficiency of 49 continental state police services of the United States of America by multiple stage DEA model. A complex structure of variables with certain demographic and economic information is developed. Finally, the finding is that more than half the states were operating under less than optimal scale.

Wu et al. (2010) apply three stage DEA model to measure the performance levels for the police forces across Taiwan. Further, the study includes three inputs, general operating cost, labor cost and equipment purchasing cost with six outputs including the number of burglaries cleared up, number of violent crimes cleared up, number of other crimes cleared up, number of road/traffic accidents resulting deaths, number of general and special service and resident satisfaction with public security. The environmental factors to the DEA model are explicitly incorporated and found that the efficiency of all DMUs is as high as 98.46 per cent when external

environmental factors were accounted for simplicity of the analysis short codes of districts have been mentioned in place of full name in the productivity results. Furthermore, views of high police officials have also been considered in order to finalize variables and policy recommendations. Technical efficiency scores are further decomposed to attain the productivity estimates with respect to time.

III. The Methodoloty

There are two main parallel approaches to measure the efficiency of police service which includes:

1. Stochastic frontier analysis (SFA).
2. Data envelopment analysis (DEA).

1. Comparison of SFA and DEA

Stochastic Frontier Analysis is a regression based parametric analysis to check the efficiency level. Under SFA the relationship between inputs and outputs is not required to be linear. Besides, SFA assumes the gap between the observed and actual efficiency which is not because of inefficiency, but in fact, it is because of the data error or the missing variables. SFA is a parametric approach which means danger of imposing wrong functional form which will always be there. As far as the relationship between inputs and outputs, distribution of random error and inefficiency is concerned, SFA requires special assumptions about these issues. SFA cannot easily handle much of the inputs and outputs in comparison to DEA [Read (1998)].

SFA does not readily provide information about peers and targets as it is provided in the DEA which is well renowned non-parametric approach to measure technical efficiency for more than one producer. On logical grounds, DEA is considered better technique as it provides role models for inefficient departments; it further provides the target level along with the optimum level of operations. Unlike SFA, advance use of DEA, also provide productivity estimates which are obtained after decomposing the technical efficiency estimates. This technique differs in mechanism with a central tendency approach, as under the DEA, comparisons with only best or efficient producer rather than the average producer is made.

Managers have more inclination towards DEA because with this technique they have very few chances to miss important opportunities for improvement. Under DEA literature, the producer is referred as a decision making unit. DEA is a non-parametric approach to check the relative efficiency of different entities performing similar tasks. This approach is based on linear programming to measure the efficiency of decision making units (DMU). In this analysis, Punjab police is considered as one production unit and districts as DMUs performing similar duties.

Through DEA, the efficiency scores can be generated from zero to one; units below one can be rated as inefficient, whereas, units receiving a full score (which is one) can be called efficient.

2. Legal System and Variables

The analysis of this study is based on number of reported crimes because it creates the foundation for subsequent work for prosecution and investigation. Consequently, a number of prevented crimes were ignored because it was nearly impossible to calculate such statistics. The criminal justice system is largely uniform across the country. The simple criminal laws define criminal behavior; recommends police process and give evidence demonstration in the courts which are alike throughout the country. The Code of Criminal Procedure, 1898 (as amended by Act II of 1997) forms the basic legal system for police procedure.

Based on the empirical literature and suitability of the available data, the inputs and outputs are selected (see Table 1).

Under the empirical literature there is an excellent discussion by Drake and Simper (2004) about choosing the inputs and outputs for analysis of police service efficiency. These variables were considered after in-depth discussion with professionals and after detailed review of the available literature. Similar, inputs and outputs have been used by Verma and Gavirneni (2006) in their efficiency analysis of Indian police. These variables offer essential information about the Punjab police and can be useful to compare relative efficiency of the police units. The selection of these inputs and outputs enabled to used production approach which is related to the analysis of technical efficiency. This two-fold dissimilarity, including production and cost approach for choosing the variables, was first found in Drake and Simper (2004). In this study the first three variables have been considered as inputs and the last three as outputs.

3. Model Formulation

The mathematical formulation of DEA is expressed as:

If there are N decision making units, each DMU with 'm' inputs and 'n' outputs, the relative efficiency score of individual DMU is obtained by solving the following model proposed by Charnes et al. (1978):

For each DMU_p, p = 1, 2, 3, …

$$\text{maximize: } E_p = \sum_{j=1}^{n} u_j y_{jp} \,/\, \sum_{k=1}^{m} u_k y_{kp} \qquad (1)$$

TABLE 1

List of Inputs and Outputs

INPUTS	OUTPUTS
TECR	NPCS
'Total Number of Expenditure' in PKR made at the mentioned time intervals. Expenditures are one of the primary inputs to improve efficiency of the police units. It has been considered as one of the key monetary inputs to derive the police efficiency.	Means 'Number of Persons Charge Sheeted' after considering all the above inputs, here the first output of police unit after registration of the case. In this study, the term charge sheeted indicates number of people challenged by the police.
NPO	NTC
'Number of Police Officers' in pertinentdistrict or region. Law and order cannot be assured without proper police force; therefore, it is again an important input to police units.	Indicates 'Number of Trials Completed'. Sometimes complainant and defendant agreed before the court proceedings, so NTC is always less than the NPCS, but it is again one of the valuable output of our police unit which cannot be negated.
TNIC	NPC
'Total Number of Cases to be Investigated'. Investigated cases refer to reported crimes as all reported crimes are subject to be investigated for the police department. In production based analysis it plays a vital role in determining the output.	'Number of Person Convicted' per year. It is the last output of police workwhich is considered. As after conviction the offender is sent to jail as per judgment of the court.

Source: Authors' compilation.

$$\text{subject to: } (\sum_{j=i}^{n} u_i y_{ji} \,/\, \sum_{k=1}^{m} u_k y_{ki}) \leq 1 \ \forall i \tag{2}$$

$$v_j, v_k \geq 0 \ \forall_j, k$$

where

k = 1, 2 ,3…….n,
j = 1, 2, 3……..m,
i = 1, 2, 3……..N,
y_{ji} = amount of output j produced by i^{th} unit,
x_{ki} = amount of inputs k utilized by i^{th} unit,
υ_j = weights given to output j,
v_k = weights given to inputs k.

The problem set given above can be transformed into linear programming, as follows:

$$\text{maximize: } \sum_{j=1}^{n} u_j y_{jp} \tag{3}$$

$$\text{subject to: } \sum_{k=1}^{m} v_k x_{kp} = 1 \tag{4}$$

$$\sum_{j=1}^{n} u_j y_{ji} - \sum_{k=1}^{m} v_k x_{ki} \leq 1 \ \forall i$$

$$\upsilon j, \ vk \geq 0 \ \forall j, k$$

The weights are not known a priori. The unknown weights of the outputs υj and weights of the inputs νk are calculated by DEA, constructed on the available data set, as a way of attaining a measurement of relative efficiency of individual DMU. The weights are calculated distinctly for each unit so that the level of maximum efficiency can be obtained. Furthermore, the weights should be positive so that the possibility that some inputs or outputs may be missing in the process of determination of the efficiency of each DMU which can be avoided. In solution of the above mathematical program, a conforming DMU, is said to be efficient and will lie on the efficiency frontier, if $E_p = 1$. If the efficiency value is less than one, then the corresponding DMU is inefficient and it does not lie on the efficiency frontier.

a) Malmquist Productivity Index

The Malmquist productivity index (MPI) was introduced by Caves et al. (1982) and later, Fare et al. (1992) constructed the DEA based MPI as geometric mean of

two MPI of Caves et al. (1982). The MPI measure productivity variations with respect to time deviation and can be further decomposed into changes in efficiency and technology. Therefore, under the DEA, MPI is a technique which measures efficiency change in two or more time periods. Economic studies have used the MPI to estimate the total factor productivity [Kortelainen (2008)]. Technical and allocative efficiencies are two noticeable categories of production efficiencies. Technical efficiency referred as DMU's potential to increase the quantities of output for given quantities of inputs; while the allocative efficiency of DMU equates its marginal product with its marginal cost.

The output MPI can be stated in the following way:

$$M_0\left(x^{t+1}, y^{t+1}, x^t, y^t\right) = \frac{D_0^{t+1}\left(x^{t+1}, y^{t+1}\right)}{D_0^t\left(x^t, y^t\right)} \times \sqrt{\frac{D_0^t\left(x^{t+1}, y^{t+1}\right)}{D_0^{t+1}\left(x^{t+1}, y^{t+1}\right)} \times \frac{D_0^t\left(x^t, y^t\right)}{D_0^{t+1}\left(x^t, y^t\right)}}$$

The term outside the bracket represents the change in technical efficiency, whereas the geometric mean of two ratios is inside the bracket measure which shows the change in technology between the two periods t and t+1; it can be called progress in technology. Therefore,

$$\text{Efficiency change} = \frac{D_0^{t+1}\left(x^{t+1}, y^{t+1}\right)}{D_0^t\left(x^t, y^t\right)}$$

$$\text{Technical change} = \sqrt{\frac{D_0^t\left(x^{t+1}, y^{t+1}\right)}{D_0^{t+1}\left(x^{t+1}, y^{t+1}\right)} \times \frac{D_0^t\left(x^t, y^t\right)}{D_0^{t+1}\left(x^t, y^t\right)}}$$

where

x^t = input vector in period of time t,
y^t = output vector in period of time t,
D^t = distance function at period of time t,
D^{t+1} = distance function at period of time t+1,
x^{t+1} = input vector at period of time t+1,
y^{t+1} = output vector at period of time t+1.

In order to avoid arbitrarily choosing one frontier to compute the index, the geometric mean can be applied as follows:

$$M_0\left(x^{t+1}, y^{t+1}, x^t, y^t\right) = \sqrt{\frac{D^t\left(x^{t+1}, y^{t+1}\right)}{D^t\left(x^t, y^t\right)} \quad \frac{D^t\left(x^{t+1}, y^{t+1}\right)}{D^{t+1}\left(x^t, y^t\right)}}$$

The MPI also helps to measure the relative productivity of DMUs (Punjab police stations in districts in this case) at the production point (x_{t+1}, y_{t+1}) with production points (x_t, y_t).

If MPI showing the result t >1 means a gain in productivity, the result showing t<1 means a loss in productivity; and if the index results = 1 then it shows no change in productivity from time period t to t+1. Scale efficiency is also component affecting relative change as depicted in the following equation [Fare et al.(1994)].

$$\textit{Productivity Change} = \textit{Scale Efficiency Change} \times \textit{Technical Efficiency Change} \times \textit{Technical Change}$$

The benefit associated with MPI is that, it does not require information pertaining to price of inputs or outputs. Furthermore, it demands no assumption related to profit maximization or cost minimization [Fare et al. (1992)].

IV. The Data

Before the year 2006, the data of the Punjab police was neither centralized nor was it computerized in the province. Now, there are thirty-six districts in the province of Punjab in which the police is operating forces to ensure law and order situation. The District of Chiniot became the 36th district of Punjab in February 2009; it was a part of the District of Jhang. However, still in the police record there is no separate data for the reported crimes of this district. Therefore, in order to avoid the segregating base problems, Chiniot is not considered as a separate jurisdiction.

Thus, a panel data set of 35 districts across Punjab has been taken from the Investigation Branch, Finance Department, National Criminal Database, National Police Bureau and the Inspector General Office. This data set consists of six years from 2007 to 2012.[1] For simplicity of the analysis, short codes of districts have been mentioned in place of full name in the productivity results. Furthermore, views of high police officials have also been considered in order to finalize variables and policy recommendations. Technical efficiency scores are further decomposed to attain the productivity estimates with respect to time.

V. The Empirical Results

In this section, first the efficiency of 35 districts of Punjab police is measured; second, the district-wise efficiency scores are analysed, comparatively. Subsequent tables and graphs illustrate comprehensive results of efficiency analysis and real factor productivity change, using the DEAP 2.1 software.

[1]Due to its sensitive nature, the data is partially available on: http://punjabpolice.gov.pk.

1. The Technical Efficiency Result

Using the inputs and outputs from 2007 to 2012, Rawalpindi, Sheikhupura, Sialkot, Attock, Sargodha, Pakpatan, Bhawalpur, Bhawalnager and Jhang are efficient districts. Out of 35 districts, 9 are operating on efficiency frontier, whereas, rest of the 26 districts are operating below the efficiency frontier. The above estimates also reveal the least performing districts which are Khanewal, Nankana, Gujrat, Mandi Bahauddin, Chakwal, D.G. Khan and Rajanpur.

2. The Output Targets and Slacks

In consideration of the district-wise data of Punjab Police, Table 3 shows the target levels for all the three outputs. Lahore, Gujrawala, Faisalabad, Multan and Nankanabeing the mega cities of the province, consume higher inputs. Therefore, they result in higher output targets as seen in Table 3. Another advantage of using the 2ndstage DEA is that it also reveals the efficiency gap (slack) which should be filled by the DMUs. Lexical meaning of 'slack' is lagging behind. Here, it shows the laziness of the DMU in a quantitative way. Mathematically speaking, slacks are such non-negative quantities which are needed to convert inequality to equality. In Table 3 output slacks are calculated through the 2nd stage DEA. These output slacks are needed for the inefficient district to operate on efficiency frontier. In order to enhance efficiency level Khanewal needs the biggest improvement in the NTC.

3. The Detected Issues in Inputs

Tables 4 show more comprehensive and individual results for all DMUs. It includes the issues in dentified in the inputs. The 2nd stage DEA gives 'slack movement'. Its negativity means excess of input. Here NECR and NPO are negative in some cases which shows excess of those inputs. In particular, 'overstaffing' and 'wasteful expenditure' are the two issues detected through the negative slack movement.

Rawalpindi, Sheikhupura, Sialkot, Attock, Chakwal, Sargodha, Khanewal, Pakpatan, Bhawalpur, Bhawalnagar, Jhang and T.T. Singh does not have the issue of overstaffing and wasteful expenditure. These districts show exemplary performance when it comes to proper utilization of resources, while Nankana, Okara, Narowal, Vehari and R.Y. Khan are the districts which suffer with both overstaffing and wasteful expenditure.

TABLE 2

Technical Efficiency of Districts

Districts	Technical Efficiency
Lahore	0.909
Gujrawala	0.860
Rawalpindi	1.000
Faisalabad	0.883
Multan	0.888
Nankana	0.821
Kasoor	0.899
Sheikhupura	1.000
Okara	0.899
Hafizabad	0.855
Gujrat	0.871
M.B.Din	0.873
Sialkot	1.000
Narowal	0.944
Attock	1.000
Jehlum	0.990
Chakwal	0.846
Sargodha	1.000
Khushab	0.937
Mianwali	0.963
Lodrahan	0.829
Khanewal	0.760
Vehari	0.998
Sahiwal	0.886
Pakpatan	1.000
D.G. Khan	0.842
Rajanpur	0.860
Muzafargarh	0.851
Laiyah	0.933
Bhawalpur	1.000
Bhalwanagar	1.000
R.Y. Khan	0.921
Jhang	1.000
T.T. Singh	0.987
Bhakar	0.975
Overall Mean	**0.922**

Source: Authors' estimation.

TABLE 3

Summary of Output Targets and Slacks

Districts	NPCS		NTC		NPC	
	Target	Slack	Target	Slack	Target	Slack
Lahore	59411.88	0.00	11021.96	8477.20	5664.91	3685.65
Gujrawala	59913.06	0.00	11407.11	3906.50	5941.19	0.00
Rawalpindi	49861.00	0.00	11084.00	0.00	8369.00	0.00
Faisalabad	62889.04	0.00	12074.71	6769.30	6295.05	2167.62
Multan	68403.24	0.00	12683.68	6246.12	6517.59	1597.61
Nankana	61441.22	0.00	12087.50	6177.16	6363.11	2598.22
Kasoor	14319.71	0.00	4273.14	746.59	2549.43	423.04
Sheikhupura	13414.00	0.00	6450.00	0.00	5109.00	0.00
Okara	14934.01	0.00	4456.45	1650.21	2658.79	860.98
Hafizabad	17917.78	0.00	5218.38	910.62	3085.16	0.00
Gujrat	21295.10	0.00	5423.12	2709.41	3109.00	1707.93
M.B. Din	18674.11	0.00	5182.13	2956.26	3038.72	1644.55
Sialkot	11183.00	0.00	9472.00	0.00	3459.00	0.00
Narowal	11549.73	0.00	8672.37	0.00	3888.42	0.00
Attock	12065.00	0.00	9231.00	0.00	4996.00	0.00
Jehlum	11986.27	94.36	9665.72	0.00	4330.12	0.00
Chakwal	15243.51	0.00	7848.64	0.00	4336.46	244.35
Sargodha	44490.00	0.00	7519.00	0.00	3704.00	0.00
Khushab	22621.02	0.00	8047.91	1028.15	4775.92	0.00
Mianwali	19122.56	0.00	15503.80	0.00	5692.07	1441.11
Lodrahan	25841.96	0.00	10781.76	0.00	6235.47	0.00
Khanewal	27331.22	0.00	12623.92	0.00	6329.71	201.89
Vehari	11352.66	9082.10	8934.79	0.00	4382.69	0.00
Sahiwal	24771.31	0.00	12638.38	0.00	7761.35	1297.75
Pakpatan	7894.00	0.00	3981.00	0.00	3313.00	0.00
D.G. Khan	11148.29	0.00	5209.66	0.00	3048.21	34.96
Rajanpur	12336.13	0.00	5199.23	304.07	3064.27	0.00
Muzafargarh	13022.61	0.00	5580.28	0.00	3315.05	454.97
Laiyah	14110.53	0.00	5876.98	0.00	3557.23	1083.84
Bhawalpur	13657.00	0.00	7355.00	0.00	4536.00	0.00
Bhawalpur	6538.00	0.00	1951.00	0.00	1164.00	0.00
R.Y. Khan	5515.43	0.00	1645.86	345.43	981.95	218.84
Jhang	4483.00	0.00	2018.00	0.00	1104.00	0.00
T.T. Singh	4252.98	0.00	1659.45	0.00	932.69	97.90
Bhakar	5542.04	0.00	2319.78	0. 00	1348.09	15.91
Mean	**22621.02**	**262.19**	**8047.91**	**1206.49**	**4775.92**	**565.06**

Source: Authors' calculations.

TABLE 4

Detected Issues in Inputs

Districts	Issues in Inputs	Districts	Issues in Inputs
Lahore	Overstaffing	Khushab	Overstaffing
Gujranwala	Overstaffing	Mianwali	Wasteful Expenditure
Rawalpindi	–	Lodrahan	Overstaffing
Faisalabad	Overstaffing	Khanewal	–
Multan	Overstaffing	Vehari	Wasteful Expenditure, Overstaffing
Nankana	Wasteful Expenditure, Overstaffing	Sahiwal	Wasteful Expenditure
Kasoor	Wasteful Expenditure	Pakpatan	–
Sheikhupura	–	D.G. Khan	Overstaffing
Okara	Wasteful Expenditure, Overstaffing	Rajanpur	Overstaffing
Hafizabad	Wasteful Expenditure	Muzafargarh	Wasteful Expenditure
Gujrat	Wasteful Expenditure	Laiyah	Wasteful Expenditure
M.B. Din	Wasteful Expenditure	Bhawalpur	–
Sialkot	–	Bhawalnagar	–
Narowal	Wasteful Expenditure, Overstaffing	R.Y. Khan	Wasteful Expenditure, Overstaffing
Attock	–	Jhang	–
Jehlum	Wasteful Expenditure	T.T. Singh	–
Chakwal	–	Bhakar	Wasteful Expenditure
Sargodha	–		

Notes: A negative slack shows excess of inputs. In case of NPO, it shows overstaffing while the NECR represents wasteful expenditure.
Source: Authors' calculations.

4. TFP and other Effciency Scores

Table 5 summarizes changes in efficiency scores for all districts. For well performing districts (Rawalpindi, Sheikhupura, Sialkot, Attock, Chakwal, Sargodha, Khanewal, Pakpatan, Bhawalpur, Bhawalnagar, Jhang and T.T. Singh), the technical efficiency, pure efficiency and the total factor productivity are mostly greater than one. It shows that the districts without issues of 'overstaffing' and 'wasteful expenditure' have higher efficiency scores. It is in line with findings of Table 4. Nankana, Okara, Narowal, Vehari and R.Y. Khan have less than one efficiency scores, which is expected due to coexistence of 'overstaffing' and 'wasteful expenditure' in their inputs.

VI. Conclusion

The paper conducted efficiency analysis of Punjab police covering 35 districts. Productivity estimates obtained by decomposing technical efficiency into change in technical efficiency, change in total factors productivity, change in pure efficiency, technological change and change in scale efficiency. The results of an average technical efficiency for 6 years revealed that only 9 districts are efficient on production frontier. Rawalpindi, Sheikhupura, Sialkot, Attock, Sargodha, Pakpatan, Bhawalpur, Bhawalnager and Jhang are efficient DMUs under the constant return to scale assumption. In scale efficiency, Bahawalpur and Okara are on top with 98 per cent and Sahiwal is at bottom with 92 per cent. One encouraging indicator in these results is that for time period 2007-2012, majority of the districts are efficient in technical efficiency.

The average technological change and change in total factor productivity remains below the efficient score. This indicates the need to invest in human capital by training the staff properly and equipping the police with modern equipment and machinery, so that districts can operate at the optimal level. In the summary of MPI average, it was also found that Hafizabad, Bhakar, Khushab and Lodhrahan are leading among the districts. Gujrawala, Nankana, Kasoor and Gujrat are identified as most inefficient districts with lowest productivity estimates.

1. Policy Recommendations

The results disclose some policy measure for Punjab police. Policy suggestions are on two different categories which include empirical results based and observation based recommendations. Six months were spent on data collection and unstructured interviews were conducted with high ranked police officers. Therefore, some of the recommendations are based on observations of these interviews.

TABLE 5

Malmquist Index Summary of Punjab Police District Wise Averages

Districts	Effch	Techch	Pech	Sech	Tfpch
Lahore	1.000	0.884	1.000	1.000	0.884
Gujranwala	0.986	0.977	0.997	0.99	0.964
Rawalpindi	1.023	0.991	0.994	1.029	1.013
Faisalabad	1.010	0.912	1.000	1.01	0.921
Multan	1.013	0.942	1.000	1.013	0.955
Nankana	0.970	0.934	0.972	0.997	0.906
Kasoor	0.997	0.976	0.999	0.999	0.973
Sheikhupura	1.057	0.996	1.069	0.989	1.053
Okara	0.972	1.055	0.977	0.996	1.026
Hafizabad	1.002	1.004	1.007	0.994	1.006
Gujrat	0.975	0.978	0.984	0.991	0.953
M.B. Din	0.979	1.008	0.986	0.993	0.986
Sialkot	1.057	1.000	1.083	0.976	1.057
Narowal	1.063	0.956	1.096	0.97	1.017
Attock	1.094	0.915	1.100	0.995	1.002
Jehlum	1.089	0.911	1.091	0.998	0.992
Chakwal	1.062	0.936	1.071	0.992	0.994
Sargodha	1.030	0.997	1.032	0.999	1.027
Khushab	1.055	0.962	1.020	1.035	1.015
Mianwali	1.040	0.952	1.020	1.020	0.990
Lodrahan	1.054	0.961	1.013	1.041	1.013
Khanewal	1.031	0.953	1.012	1.019	0.983
Vehari	1.000	0.833	1.000	1.000	0.833
Sahiwal	1.050	0.941	0.988	1.064	0.988
Pakpatan	1.004	0.960	1.010	0.994	0.964
D.G. Khan	1.017	0.937	1.025	0.992	0.953
Rajanpur	1.021	0.852	1.029	0.992	0.870
Muzafargarh	1.042	0.916	1.049	0.993	0.954
Laiyah	1.048	0.943	1.054	0.994	0.988
Bhawalpur	1.099	0.888	1.110	0.989	0.975
Bhawalnagar	1.076	0.945	1.052	1.023	1.017
R.Y. Khan	0.991	0.995	0.983	1.009	0.986
Jhang	1.041	0.967	1.040	1.002	1.007
T.T. Singh	1.010	0.979	1.000	1.010	0.988
Bhakar	1.079	0.963	1.058	1.019	1.039
Mean	**1.029**	**0.951**	**1.026**	**1.003**	**0.979**

Note: Effch = Technical Efficiency Change, Techch = Technological Change, Pech = Pure Efficiency Change, Sech = Scale Efficiency Change, Tfpch = Total Factor Productivity Chang.

Source: Authors' calculations

a) Recommendations Based on Empirical Findings

i) Empirical results reveal that majority of the districts are operating below efficient level. Almost 7 per cent of yearly budget of Punjab is spent on police department. Thus, when such a huge chunk of tax payers' money is spent on police, therefore, it is better to set up district-wise yearly efficiency targets for this department. Nadeem (2002) also recommends district targets so that the police can set goals in coordination with the civil society and collectively they can ensure better law and order situation and improve efficiency of the police department. Accordingly, this research has calculated targets by applying the 2nd stage DEA. Districts with overstaffing and wasteful expenditure should be downsized and their budget should be curtailed to avoid wastages.

ii) After setting district wise yearly targets, monetary incentives should be given for achieving these targets. Instead of straight annual increment in salaries, which is observed from the data (wasteful expenditure), performance based incentives or increase in salary should be introduced. Almost 85per cent annual budget of Punjab police is spent on salaries [Ali (2015)]. This will create output oriented competition and hence efficiency among districts will increase.

b) Recommendations Based on Observation

i) On the basis of observations and interviews with the relevant personnel, proper training of police professionals at regular time intervals is recommended. Training will help the police to respond in minimum possible time to the reported crimes, along with better interrogation which could result in higher convictions and can lower the crime rate. Presently, only seven training centers are functioning for more than 180,000 police professionals in Punjab [Ali (2015)]. The training may consist of several modules which include:

ii) Better and effective way to interrogate criminals.

- How to use the advance equipment and machinery and other investigation tools? Developing a responsible working attitude.
- Awareness about law and legal clauses.
- Punjab police is prey to political and substandard recruitments; in fact jobs are sold [Ashraf (2013)]. Merit based recruitment creates a positive and accountable environment for professionals to perform with efficiency. Recruitment on pure merit are recommended.

c) Future Research

Further research should be undertaken by using data on police stations, emphasizing on size, qualification of police force and such other features. Data on such variables was not available for police stations in all districts of the Punjab. Tobit regression can be used to estimate the impact of such variables of efficiency score of police stations.

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