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Assessing Efficiency of Local Police Agency Using Data Envelopment Analysis

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Abstract

The purpose of this paper is to measure the relative efficiency of the police agencies in Korea with data collected from 2018 to 2020, using data envelopment analysis (DEA), as put forward by Charnes et al., which is used to construct a scalar measure of efficiency for all police agencies. The results of this study can be used to assist police agencies in delivering better and more efficient services to the community. The analytical results based on DEA identify potentially weak and strong police agencies on policing performance, their efficient benchmarking, and the levels of clear-ups that would make inefficient police agencies efficient. We could suggest that higher levels of the police force are associated with higher performance efficiency against crimes. But, it is a little hard to say that higher levels of the police force can keep the local police agencies efficient without explaining the contribution of other input variables to criminal arrest and prevention. On the other hand, our analysis presents that differences in operating environments and socioeconomic factors do not have a significant influence on the efficiency of local police agencies. But, it is necessary to note that we need to examine the effect of environments and socioeconomic factors on crime to create the better-policing performance.

Keywords: Efficiency, Local Police Agency, Input, Output, Data Envelopment Analysis

1. INTRODUCTION

With advanced methods of criminals and patterns of future crime becoming serious, police organizations or officers are more likely to rely on much more resources for criminal arrests that include police personnel, vehicles, high-quality police equipment, tools for forensic investigation, and surveillance cameras. Whether increased police resources have contributed to preventing or tackling crime or not is worth being discussed in terms of the efficient utilization of resources. Since New Public Management from the 1980s in the public sector, efficiency has been one of the most influential administrative ideologies in the developed world. Under NPM, the rapid growth of police resources in South Korea was a hot issue because of the argument that increased police force and budget have no correlation with a decrease in crimes.

In the past few decades, there have been two major trends for governments to achieve a greater administrative efficiency: a) leading to expenditure reduction and efficiency of resources based on scale economies [1]; b) increasing efficiency by specializing public expenditure through stimulating competition [2]. Measuring the efficiency of public agencies has become a core topic of argument over responsibility and accountability for organizational performance. Given the assessment, organizations with higher efficiency can play best practices in performance benchmarks to ones with lower efficiency.

The efficient use of resources by the police to achieve as much output as possible is not only a way of

fulfilling the responsibility of the people but also a way of survival to enhance the organization's competitiveness. With the growth of brutal crimes these days, in particular, the performance of police crime prevention and criminal arrest determines the public's trust in the value of police presence. Therefore, it would be worth arguing that how efficiently the police use input resources to detect criminals is an important matter directly related to public trust. Is the police organization efficiently conducting police activities to cope with various crime prevention and criminal arrest? That question is to check out whether there is the squandering of the nation's resources involved in these activities.

The purpose of this paper is to measure the relative efficiency of the police agencies in Korea with data collected from 2018 to 2020, using data envelopment analysis (DEA), as put forward by Charnes et al. [3], which is used to construct a scalar measure of efficiency for all police agencies. The results of this study can be used to assist police agencies in delivering better and more efficient services to the community.

2. INPUT AND OUTPUT VARIABLES

Research on efficiency of municipalities and local government services provision may be grouped into two main streams. The first stream includes studies that focus on the assessment of efficiency of single services including local police force [4]. The second stream includes studies that are aimed at assessing an overall municipal efficiency score. In this stream, scholars have conducted a number of empirical investigations that cover several countries [2].

Researchers are interested in understanding what determinants of efficiency are in an organization. They have investigated them, including financial factors, environmental issues, managerial capabilities, size, economies of scope, economies of scale, etc. Economies of scale might be an important factor to take into account to explain different rates of efficiency [2].

Thanassoulis [5] used an output-orientated CCR (Charnes, Cooper and Rhodes [3]) model to analyze 41 police forces in England and Wales using data for the years 1992-1993. The production model consisted of four inputs: police officers employed at each force, number of violent crimes, burglaries, and other crimes recorded; and three outputs: number of ''clear ups'' of violent crime, burglary, and other crimes recorded. Carrington et al. [9] examined the technical efficiency of the New South Wales (NSW) Police Service in 1994–1995, using a two-stage procedure. In the first stage, input-orientated CCR and BCC (Banker, Charnes, and Cooper [6]) models were used to compute the technical efficiencies of 163 police patrols. Their production model consisted of three inputs (police officers, civilian employees, and police cars) and five outputs (number of offences, arrests, summons, major car accidents recorded, and kilometers traveled by police cars). In the second stage, Tobit regression was used to analyze external factors or operating environments of patrols (i.e., the proportion of young people, proportion of government housing, and location).

Sun employed data envelopment analysis to measure the relative efficiency of the 14 police precincts in Taipei city, Taiwan [7]. Our results indicate how DEA may be used to evaluate these police precincts from commonly available police statistical data for the years 1994-1996. To sharpen efficiency estimates, Shinn used four input variables: officers, burglaries, offenses, and other crimes, and three output variables: burglary clear up, offense clear up, and other crimes clear up.

Based on prior studies of police efficiency, we use the following inputs and outputs to evaluate the efficiency of police agencies:

(1) input measures:
   · number of people per police officer in the local police agency;
   · number of police stations in the local police agency;
   · number of police station branches in the local police agency;
   · number of police officers employed;
   · number of police vehicles for patrol;
   · number of surveillance cameras for crime prevention.

(2) output measures:

· number of various crime clear ups;
· rate of criminals arrested.

3. METHOD AND SAMPLE

The research employs DEA to measure the efficiency of local police agencies as decision units. Both parametric and non-parametric techniques are generally used to assess unit efficiency in the public sector [8]. The non-parametric approach that uses DEA has several advantages. DEA is a deterministic programming technique that extends the Farrell's efficiency measure to a multiple outputs, multiple inputs setting, and adopts very weak assumptions related to the estimation of the empirical production function converting inputs into outputs for each local police agency. This technique relies only on simple assumptions such as the convexity and strong free disposability in inputs and outputs. The production frontier is generated solving a sequence of linear programming problems, one for each local police agency included in the sample, while the relative technical efficiency rate (TE) of the local police agency is measured by the distance between the actual observation and the frontier obtained from all the local police agencies under examination. A local police agency is efficient if TE=1, but if TE<1 a local police agency is considered technically not efficient. Given the sample of local police agencies, the model determines for each local police agency the optimal set of input weights and output weights that maximize its efficiency score. DEA models can be either input or output oriented. In the study an input orientation is adopted and the production function is constructed by searching for the maximum possible proportional reduction in input usage, while output levels are held fixed. This choice is common in this kind of studies, because usually public expenditure is used as an input. As the sample includes local police agencies having different size, efficiency was calculated adopting the conceptualization suggested by Banker, Charnes and Cooper (1984) [6], thus assuming variable returns to scale (VRS) (BCC model). An input-oriented BCC LP model is defined as:

$$\min_{\emptyset\lambda}\theta$$
$$\text{subject to } -y_i + Y_\lambda \geq 0$$
$$\Theta\chi_i - X\lambda \geq 0$$
$$N1'\lambda = 1$$
$$\lambda \geq 0$$

where Y denotes a matrix of output measures, X a matrix of input measures, $1'\lambda=1$ is the convexity constraint added to the CCR model (Charnes, Cooper, & Rhodes, [3]) that assumes constant returns to scale (CRS). The total technical efficiency (TECRS) can be decomposed into pure technical efficiency (TEVRS) and scale efficiency (SEa), where $SE_a = TE_{CRS}/TE_{VRS}$ [9]. To find out whether a local police agency is scale efficient and qualify the type of returns of scale, a DEA model under the non-increasing returns to scale (NIRS) is implemented by replacing the N1'≤ 1 restriction with N1'$\lambda \leq 1$, putting $SE_b = TE_{CRS}/TE_{NIRS}$, and the following rule can be applied [10] if SEa=1, then a local police agency is scale efficient, both under CRS and VRS; if SEb=1 it operates under increasing returns to scale; if SEb<1, it operates under decreasing returns to scale.

4. ANALYSIS AND RESULTS

Table 1 displays the outcome of DEA. Average CCR and BCC efficiency scores are 97.01% and 97.63%, which are rather high rates for studies on this subject. Minimum efficiency scores are 83.27% and 85.62% for the CCR and BCC models, respectively. The number of 100% efficient police stations in the CCR and BCC models is 62.5 and 68.8. The BCC inefficiency score of 5 local police agencies does not remain below sample average.

The findings reveal a production technology with variables returns to scale. Six local police agencies are

scale inefficient; in particular, no local police agencies have decreasing returns to scale, while 6 have increasing returns to scale. These findings apparently support the idea that there might be important scale efficiencies that make organizational resources of local police agencies efficient. Efficiencies are mostly due to increasing returns rather than decreasing returns to scale.

The average size of police officers contributes to having increasing returns to scale, but the number of police stations in the local police agency and the numbers of police station branches in the local police agency make local police agencies inefficient. However, data relative to the number of police vehicles for patrol and the number of surveillance cameras for crime prevention reveal that things are more complex and a more in depth investigation about determinants of inefficiency is necessary.

The findings of this analysis stimulate further meditation about two major issues. First, merging to benefit from scale economies may not be the only alternative for the local police agencies. Both small and large police agencies may increase their operational and financial efficiency by clearing ups various crimes. Second, factors such as the environment uncontrollable variables might be more important than input variables to explain greater efficiency.

Table 1. DEA efficiency scores

DMU	Local Police Agency	CCR	BCC	NIRS	RtS
DMU1	A	100.00	100.00	100.00	crs
DMU2	B	100.00	100.00	100.00	crs
DMU3	C	100.00	100.00	100.00	crs
DMU4	D	93.72	96.78	96.78	irs
DMU5	E	100.00	100.00	100.00	crs
DMU6	F	100.00	100.00	100.00	crs
DMU7	G	98.89	100.00	100.00	crs
DMU8	H	100.00	100.00	100.00	crs
DMU9	I	100.00	100.00	100.00	crs
DMU10	J	89.59	90.37	90.37	irs
DMU11	K	83.27	85.62	85.62	irs
DMU12	L	100.00	100.00	100.00	crs
DMU13	M	100.00	100.00	100.00	crs
DMU14	N	92.50	93.89	93.89	irs
DMU15	O	94.11	95.53	95.53	irs
DMU16	P	100.00	100.00	100.00	crs
	mean	97.01	97.63		

RtS=returns to scale, crs=constant returns to scale, irs=increasing

5. DISCUSSION

This article gives an account of a DEA application to assessment of policing performance in the local police agencies, Korea. The local police agencies in metropolitan cities get rated as the most efficient in terms of overall, technical, and scale efficiencies for the years 2018–2020 using police statistical data. We show that the local police agencies can be investigated for policing performance to clear up crimes in terms of their relative efficiency. The overall policing performance was assessed by setting their clear-up levels against the crimes, including the levels of police officers and tools for preventing crimes as input resources.

The analytical results based on DEA identify potentially weak and strong police agencies on policing performance, their efficient benchmarking, and the levels of clear-ups that would make inefficient police agencies efficient. Some local police agencies in metropolitan cities already use their resources against crimes at appropriate levels. The other agencies especially in metropolitan cities with rural type are experiencing

increasing returns to scale and could improve their output levels to be efficient.

We could suggest that higher levels of the police force are associated with higher performance efficiency against crimes. But, it is a little hard to say that higher levels of the police force can keep the local police agencies efficient without explaining the contribution of other input variables to criminal arrest and prevention. On the other hand, our analysis presents that differences in operating environments and socioeconomic factors do not have a significant influence on the efficiency of local police agencies. But, it is necessary to note that we need to examine the effect of environments and socioeconomic factors on crime to create the better-policing performance.

We suggest some important input and output variables for the evaluation of efficiency in terms of policing performance. They consist of quantitative dimensions; for example, the levels of police officers. It would, however, be desirable to include these variables with qualitative dimensions; for example, client satisfaction with an appropriate methodology to measure and quantify.

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