O P E R A T I O N S R E S E A R C H A N D D E C I S I O N S

No. 2 2010

Małgorzata GUZOWSKA*,
Tomasz STRĄK*

AN EXAMINATION OF THE EFFICIENCY OF POLISH PUBLIC SECTOR ENTITIES BASED ON PUBLIC PROSECUTOR OFFICES

This article presents results of research on the efficiency of public prosecution organizational units by means of the DEA method. The study covered 45 public prosecution regions, whose technical and cost efficiency were analyzed. It also examined the impact of the returns-to-scale effect on their overall efficiency. Additionally, the authors present potential savings that could be achieved if units considered to be inefficient improved their efficiency. The results obtained show that the DEA method is very useful in analyzing the efficiency of public sector entities when a given service is rendered by more than ten such entities.

Keywords: *DEA method, efficiency, public sector, public prosecution organizational units*

1. Introduction

In this article the authors discuss the problem of analyzing the technical and cost[1] efficiency of public sector entities by means of a non-parametric DEA method. Such studies have rarely been published in the Polish literature. The authors of available research concerning the efficiency of the Polish public sector tended to concentrate on its overall condition [18], [24], while the issue of efficiency was addressed rather superficially. One

* Faculty of Economics and Management, University of Szczecin, ul. Mickiewicza 64, 71-101, Szczecin, e-mail: Strak@ms.gov.pl, malgosiaguzowska@gmail.com

[1] The nature and notion of efficiency are presented in reference books in various ways. For the sake of this study the authors have adopted the approach that is most common in the literature on financial management and efficiency analysis in the public sector, according to which efficiency is a measure of the relation between input and output, i.e. it assesses successfulness in providing products at the lowest cost while maintaining desired quality. There are two types of efficiency: technical and cost. Technical efficiency concerns a production process and indicates the maximum production that can be achieved with a given technology at various inputs. Cost efficiency additionally highlights the costs of obtaining input, i.e. economy.

of the few exceptions is the study of the efficiency of Polish universities by J. NAZARKO, M. KOMUDE, K. KUŹMICZ, E. SZUBZDY and J. URBANIAK [17].

The subject of the efficiency of public sector institutions in Europe did not emerge until the 1990s. The following studies are worth mentioning: A. AFONSO, L. SCHUKNECHT and V. TANZI [2], A. AFONSO and M.S. AUBYN [1], C. SPOTTISWOODE [26], VANDEN EECKAURT P. [30] and M. STONE [28].

Analysis of the efficiency of public sector entities within the generally understood administration of justice has not been a popular subject of scientific study. The likely reason for this is limited access to the quantitative and financial data necessary for the analyses. The most popular subject in this field is analysis of the efficiency of courts [3], [13]–[16], [20], [22], [25].

No research has been conducted yet on the efficiency of public prosecution in Poland taking into consideration cost efficiency and the returns-to-scale effect. This study is the first attempt to evaluate the cost efficiency of public prosecution entities in Poland. What is more, the authors of this paper investigate the problem much more deeply than that, since they have also focused on finding measures to evaluate the performance of public sector entities. One of the possible solutions, suggested by the authors of this study, is to evaluate efficiency indicators by means of the DEA method.

2. Nonparametric DEA method of measuring efficiency

The literature on measuring efficiency uses both parametric (econometric) and nonparametric approaches. The parametric approach is based on the production function, well known in microeconomic theory, which determines the relationship between a company's input and output. The parameters of this function are determined by means of classical tools of econometric estimation, e.g. *Stochastic Frontier Analysis*. Nonparametric approaches to efficiency analysis are based on linear programming methods, such as DEA and FDH (*Free Disposal Hull*).

The DEA (*Data Envelopment Analysis*) method, developed in 1978 by two Americans, ABRAHAM CHARNES and WILLIAM COOPER [5], is the most common method of measuring the efficiency of public sector entities. It is a deterministic method that assumes there is no random component and does not require specifying a functional relationship between the input and the output of a company. The DEA method is based on the concept of productivity from DEBREU [6] and FARREL [9], which defines productivity as the ratio of a single output to a single input. However, it is applied to multidimentional situations where we have more than one input and more than one output. They used linear programming to estimate technical efficiency measures and created their first model, called CCR or CRS (*constant return-to-scale*), where they assumed a constant scale effect.

Using this approach, in the DEA model efficiency can be defined as the ratio between a weighted sum of outputs and a weighted sum of inputs:

$$e = \frac{\sum_{r=1}^{n} \mu_r \cdot Y_r}{\sum_{i=1}^{m} v_i \cdot X_i}$$

where:

e – efficiency,
Y_r – r-th output,
X_i – i-th input,
n – the number of outputs,
m – the number of inputs,
μ_r – weights defining the importance of individual outputs,
v_i – weights defining the importance of individual inputs.

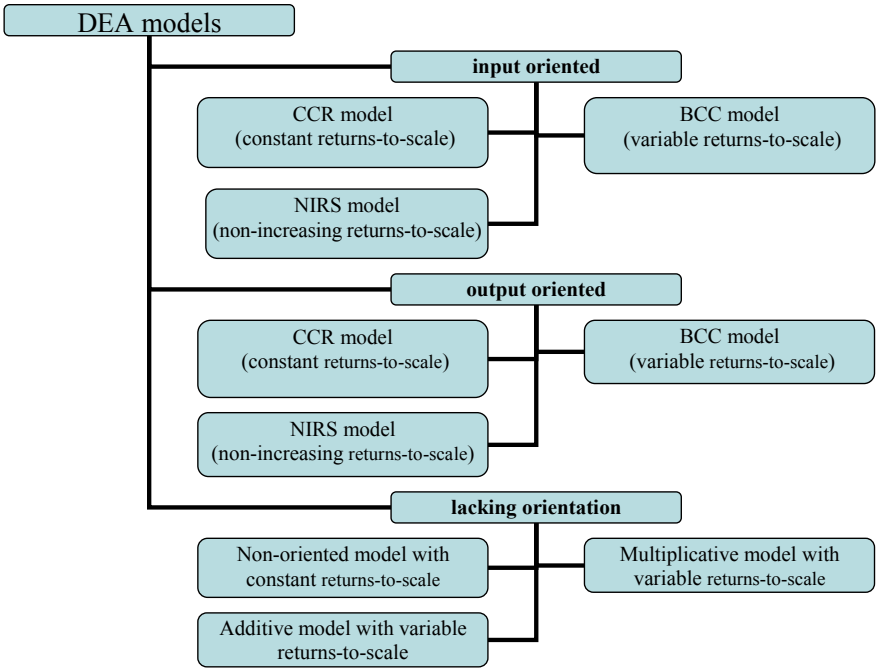

Chart 1. Types of DEA models according to orientation and returns-to-scale
Source: ROGOWSKI G. [21].

Using the DEA method, it is not necessary to know the weights in advance. The calculations derive the weights that maximize the efficiency of each individual object.

To solve such an optimization problem, the distance of the actual production level from the theoretically specified efficiency frontier is to be determined.

The DEA method allows us to determine *the production frontier* for a given decision-making unit using linear programming methods. The decision-making units (*DMUs*) located on the production frontier – considered to be *efficient*[2] – are ascribed with an efficiency coefficient equal to 1 (i.e. 100%), while the units located below the curve – considered to be *inefficient* – will have an efficiency coefficient less than 1.

Table 1. Economy of scale of objects achieved on the basis of the relationship between cost efficiency measures and scale

Type of DMU	Relationship between efficiency measures	Description
I	ecrs = 1, evrs =1 esvrs = 1, esnirs =1	Efficient DMU, irrespective of accepted efficiency measures
II	ecrs < 1, evrs = 1 esvrs < 1, esnirs = 1	DMU efficient under variable returns to scale (*evrs* = 1), but inefficient under constant returns to scale (*ecrs* < 1). DMU inefficient in terms of the number employed (*esvrs* < 1) and operating in the region of increasing returns to scale (*esnirs* = 1)
III	ecrs < 1, evrs = 1 esvrs < 1, esnirs < 1	DMU efficient under variable returns to scale (*evrs* = 1), but inefficient under constant returns to scale (*ecrs* < 1). DMU inefficient in terms of the number employed (*esvrs* < 1) and operating in the region of decreasing returns to scale (*esnirs* < 1)
IV	ecrs < 1, evrs < 1 esvrs < 1, esnirs = 1	DMU inefficient under both variable and constant returns to scale. DMU inefficient due to a low level of employment (*esvrs* < 1), operating in the region of increasing returns to scale (*esnirs* = 1)
V	ecrs < 1, evrs < 1 esvrs = 1, esnirs = 1	DMU inefficient under both variable and constant returns to scale. Such DMU are technologically inefficient, but are efficient in terms of production scale (*esvrs* = 1, *esnirs* = 1). DMU operating in the region of constant returns to scale
VI	ecrs < 1, evrs < 1 esvrs < 1, esnirs < 1	DMU inefficient under both variable and constant returns to scale. Such DMU are scale inefficient (*esvrs* < 1, *esnirs* < 1) due to too high a level of employment. They operate in the region of decreasing returns to scale

ecrs – efficiency measure under the assumption of constant returns to scale (the so called overall technical efficiency), *evrs* – efficiency measure under the assumption of variable returns to scale (the so called pure technical efficiency), *enirs* – efficiency measure under the assumption of non-increasing returns to scale, $esvrs = \frac{ecrs}{evrs}$, $esnirs = \frac{ecrs}{enirs}$.

Source: Based on WHEELOCK & WILSON [31].

[2] There are situations where an object can be defined as inefficient even if it lies on the efficiency curve. Such a situation initiates the *frontier object.* See: [4] and [23].

A decision-making unit can be regarded as technologically efficient if it lies on the efficiency frontier, and the units situated below the frontier can be regarded as technologically inefficient. The efficiency of a given decision-making unit is measured in relation to the other comparable units that are being analyzed.

To classify DEA models two criteria are used simultaneously: the model's orientation and the kind of returns-to-scale. The first criterion indicates whether inputs are minimized or outputs are maximized. The second criterion defines what assumptions concerning returns-to-scale have been adopted in the model (variable, constant or non-increasing). The chart below shows the types of DEA models.

As the above chart shows, depending on what assumptions are made regarding the type of the returns-to-scale, it is possible to estimate three types of efficiency measure. The first measure, resulting from an empirical production function assessed by assuming constant returns-to-scale (CRS), is designated according to the best units in a given branch, due to which such efficiency measures do not take into account the impact of production output on efficiency. Other measures obtained with the assumption of variable (VRS) or non-increasing (NIRS) returns-to-scale take into consideration the possible impact of the unit on production efficiency. Therefore, comparison of these three measures provides information about the relative economy of scale in a given branch.

3. DEA – the administration of justice

As mentioned in the introduction, the DEA method is applied to the generally understood administration of justice, probably because the results of DEA analysis can provide information that is valuable for the management of courts of law and prosecutor's offices. The literature review to be found below not only presents the usefulness of the DEA method as an alternative unit benchmarking tool, but also shows how effective this method is in selecting efficient units and indicating the areas of inefficiency in other units.

In Germany [22] the DEA method enabled testing the efficiency of their civil jurisdiction system. This paper presents the thesis that civil courts can be treated as a specific job market where the major motivation to work comes from opportunities to be gained by professional excellence. This hypothesis was tested on a sample of nine comparable German appelate courts (Landesarbeitsgerichte) and took into consideration the caseload of 230 judges in the period 1980–1998. To evaluate the Tribunal's efficiency, the DEA method was employed using two input variables (judges, caseload in a given year) and two output variables (number of cases finished in a given year, number of published decisions[3]). The model was output-oriented in that the default

[3] Approved and verified by the Federal Labour Court.

improvement for inefficient courts is to focus on "production growth", i.e. on the number of concluded cases instead of the number of overdue cases. The results were used to relate the efficiency of judges to their promotion opportunities.

Another example of the evaluation of efficiency in the jurisdiction system is the study [14] commissioned by the Norwegian district courts, whose efficiency was examined with the aim of suggesting ways of improving both their operation and their efficiency. This paper has three major goals: firstly, to measure the product efficiency of courts; secondly, to suggest ways of improving efficiency in case of inefficient units; and thirdly, to pool and analyse methods to be used when carrying out the first two tasks or conducting similar analysis in the generally understood public sector. The analysis covered the period of 1983–1988 and was performed mainly by means of the DEA method. The study took into consideration both urban and rural courts. The results showed a high level of technical inefficiency in courts due to understaffing. Additionally, the authors used the Malmquist index to evaluate the rate of change in productivity. Finally, the paper addresses the question of how the information from the DEA method can be used by courts to become more efficient.

Brazilian jurisdiction is notorious for its inefficiency and indolence, therefore a few studies analysing its operational efficiency have been conducted recently. The DEA method was employed in two of them. The first one [3] examined the efficiency of Brazilian courts using the DEA method. The authors presented the vast historical, cultural, political, structural and legal background of the crisis observed presently in the Brazilian judiciary system. They also suggested an initial hypothesis that the inefficient operation of the Brazilian courts is due mainly to insufficient financial and human resources, as well as the poor quality of law procedures. In their analysis they used data from annual reports published by the CNJ (National Council of Justice).

The model proposed consists of two output variables (the number of adjudications in primary and secondary courts) and three input variables (the number of judges and the number of other staff per 100,000 population, as well as the number of available computers per user).

The results obtained by the authors prove that efficiency varies significantly depending on the type of court (the DEA coefficient ranged from 1 to 0.115). It has also been proved that the hypothesis stating that insufficient human and material (financial) resources are the main inefficiency factors is not necessarily true. It is rather the malfunctioning structure of courts, their staff's lack of motivation to work and poor management quality that are the major inefficiency factors.

Another study commissioned by the Brazilian jurisdiction system [25] covered 161 courts in Rio Grande do Sul. Technical efficiency was examined by means of the FDH (Free Disposal Hull) method, as well as with the DEA method. The authors built a multidimentional model with three input variables (the number of judges, the number of other staff and the duration of court proceedings) and six output variables (the numbers of different types of cases concluded). In addition, the authors ana-

lysed how the size of a court influenced its efficiency, thus suggesting a return-to-scale effect.

The list of studies employing the DEA method also includes: one conducted in the USA [15] that examined the efficiency of courts in North Carolina, where 100 courts of law were surveyed with the goal of testing their administrative efficiency, a study in Spain [20] where the technical efficiency of courts' operations was tested; and lastly studies of the technical efficiency of appelate courts in Italy [16] and Sweden [13].

There are not many publications concerning the efficiency of prosecutor's offices. One of the few articles examining prosecutor's offices by means of the DEA method is the study by Gormana and Ruggiero [11], where the authors evaluated prosecutor's offices in the USA. On the basis of a multidimensional model, they evaluated the technical efficiency of prosecutor's offices taking into consideration their size. Due to the complex character of their services and their varied capacity, the study was conducted in a limited number of judiciary districts. The study covered districts of population from 100 to 500 thousand. Additionally, the authors analysed the dependency between the efficiency of prosecutor's offices and the social and economic situation in the districts. The results suggest that prosecutor's offices operating in regions experiencing disadvantageous social and economic conditions are less efficient.

4. Structure and tasks realised by the organisational units of prosecutor's offices

The prosecutor's offices are responsible for implementing one of the principal tasks of the state, i.e. enforcing internal security. Internal security is a classic public domain [19], [24], [27]. The state provides such goods by executing public functions in their strict sense. Fulfilling these functions is an objective necessity resulting from the very existence of society and its institutions [29]. In Poland it is the state's constitutional responsibility to enforce citizens' security (Article 5 of the Polish Constitution[4]).

What is more, the prosecutor's offices directly influence the efficiency and effectiveness of services that are responsible for fighting and preventing crime in Poland, such as the police, the Internal Security Agency (ABW) and the Central Anticorruption Bureau (CBA).

In Poland the prosecution service has executive power. It is in charge of law enforcement and supervises criminal prosecution. Thus a prosecutor functions as a public attorney and supervises preparatory proceedings in criminal cases.

[4] Journal of Laws 1997, No. 78, position 483.

The highest Polish prosecutor office is the Public Prosecutor General. Below him are the following: prosecutors in the public organisational units of prosecutor's offices, prosecutors in the military organisational units of the prosecutor's offices, prosecutors in the Institute of National Remembrance – the Commission for the Prosecution of Crimes against the Polish Nation. The prosecutor's offices are the most numerous units of the state subsector (app. 10% of all the units). The public organisational units of the prosecutor's offices (399 units) are as follows: the National Prosecutor's Office, appeal prosecutor's offices (11 units), regional prosecutor's offices (45 units) and district prosecutor's offices (342 units). Public prosecutor's offices form a hierarchical structure. The National Prosecutor's Office supervises the 11 appeal offices. Each appeal prosecutor's office controls at least two regional prosecutor's offices, which in turn control district ones.

While implementing their statutory tasks, the public organisational units of the prosecutor's offices handle criminal, civil, administrative and juvenile law cases. In 2007 the number of criminal cases registered in the public organisational units of the prosecutor's offices amounted to 1,289.7 thousand. In other areas of operation the offices registered: 75.4 thousand civil cases, 51.6 thousand administrative law cases and 15.4 thousand juvenile law cases. Criminal investigations are the main activity of the prosecution service and account for app. 90% of all matters handled by the prosecutor's offices. The district and regional prosecutor's offices deal with 99.9% of all incoming cases. Therefore, the analysis of the efficiency of public organisational units of the prosecutor's offices will be limited to the regional and district offices and criminal law cases. It will include 388 units employing 5,982 prosecutors. It is worth pointing out that district prosecutor's offices are not financially independent. They are managed financially by regional prosecutor's offices, who administrate budgetary funds of the 3rd degree. The authors of the present study decided to evaluate the efficiency of the regional offices, because they are in charge of financial management and play the role of a budgetary fund administrator for their district prosecutor's offices.

The expenditure of the public organisational units of the prosecutor's offices covered from the National Budget is stated in Part 37 (Justice), Section 755 (The Administration of Justice), Chapter 75505 (Public Units of Prosecutor's Offices). In 2008 the planned budget was 1,395,597 (thousand PLN). As far as the budgetary expenditure of public organisational units is concerned, prosecutor's offices are 12th on the list of public sector units. Thus, due to the level of expenditure, this group is very important.

5. The range of the study

The analysis deals with the operation of Polish prosecutor's offices in 2007. The authors used the following sources of data: *Statistical Information about the Opera-*

tion of the Public Organisational Units of Prosecutor's Offices in 2007[5] and the annual budget reports Rb 28 submitted by individual prosecutor's offices.

In order to examine technical and cost efficiency, the authors used both a one-dimensional model and a multidimensional model. In the case of the one-dimensional model:

1) technical efficiency was evaluated on the basis of an individual prosecutor's office's clearance rate (*Wz*), which is defined to be the ratio of the number of resolved cases in a given period of time to the number of prosecutors;

2) cost efficiency was evaluated by means of the average case cost index (*Wkp*) – total costs divided by the number of resolved cases.

The multidimensional model was based on three inputs and three outputs. The analysis of the operation of the prosecutor's offices takes into account the fact that these offices offer heterogenic services, the rendering of which requires highly qualified staff. Such types of unit include e.g. consulting, auditing or legal firms. Using such a model, inputs can be divided into three basic groups:

1) specialists offering services directly (for example solicitors dealing with specific legal matters);

2) auxiliary staff;

3) other inputs (computers, telephones, means of transport, offices, etc).

Thus, when identifying the inputs and outputs of prosecutor's offices, the authors took into account both substantial criteria and the availability of data. Simultaneously, they analysed both the expenditure of individual organisational units in the prosecutor's offices listed in 30 articles of the classification of budgetary expenditure and reports on the operation of these offices.

In the model applied to examine technical efficiency, the authors eventually decided to use the following as inputs:

1) **the number of prosecutors and assessors employed in a given prosecutor's office (X_1)**;

2) **other staff costs (X_2)** – wages and salaries, including other payments and non-personnel wages and salaries;

3) **other costs (X_3)**.

In the case of the model applied to evaluate cost efficiency, the authors decided to treat the following as inputs:

4) **the wages and salaries, including other payments, of prosecutors and prosecutor assessors (X'_1)**;

5) **other staff costs (X_2)** – wages and salaries, including other payments and non-personnel wages and salaries;

6) **other costs (X_3)**.

Basic statistics for these variables are presented in the table below.

[5] Study carried out by the Organisational Department of the Ministry of Justice, Warsaw 2008.

Table 2. Descriptive statistics of the variables X_1–X_3 for 45 prosecution regions

Descriptive statistics	X_1	X'_1	X_2	X_3	Total (X'_1–X_3)
Total amount	5982	PLN 516 563 070	PLN 308 665 428	PLN 166 702 716	PLN 991 931 214
Minimum	42	PLN 4 080 883	PLN 2 535 055	PLN 964 173	PLN 7 649 842
Maximum	393	PLN 32 661 433	PLN 21 574 362	PLN 14 164 747	PLN 68 400 541
Arithmetic mean	133	PLN 11 479 179	PLN 6 859 232	PLN 3 704 505	PLN 22 042 916
Median	92	PLN 8 093 223	PLN 4 840 027	PLN 2 693 770	PLN 15 534 980
First quartile	72	PLN 6 463 704	PLN 3 771 593	PLN 2 069 795	PLN 11 993 820
Third quartile	182	PLN 15 703 218	PLN 9 873 172	PLN 5 208 881	PLN 30 785 271
Standard deviation	91	PLN 7 490 003	PLN 4 518 294	PLN 2 675 320	PLN 14 545 534

Source: Based on the 2007 Rb 28 reports submitted by regional prosecutor's offices and on *Statistical Information*… op. cit.

The analysis did not take into account office maintenance costs (such as electricity, property tax, repairs, waste disposal, etc.) and capital costs. The level of these costs has little relation to the services that a prosecutor's office renders.

As the product of a prosecutor's office the authors chose the number of resolved criminal cases. These are divided into three groups, depending on the workload required:

1) **completed criminal cases, except discontinued ones (Y_1)**, where:
   a) a criminal offence was not committed or the evidence was not strong enough to justify suspicion that it had been committed;
   b) there were no features of criminal offence or a legal act stated that an offender did not commit the offence;
   c) an offence was socially harmless (Article 17 § 1 paragraph 1 – 3 of the Criminal Code);
2) **criminal cases discontinued due to the reasons mentioned in 1) (Y_2)**;
3) **refusal to institute proceedings (Y_3)**.

Table 3. Descriptive statistics of the variables Y_1–Y_3 for 45 prosecution regions

Descriptive statistics	Y_1	Y_2	Y_3	Total
Total amount	878 414	233 410	192 016	1 303 840
Minimum	4 367	1 237	1 324	7 423
Maximum	53 234	16 625	11 302	78 126
Arithmetic mean	19 520	5 187	4 267	28 974
Median	13 323	3 615	3 179	20 786
First quartile	9 407	2 386	2 116	15 530
Third quartile	23 778	6 418	6 252	34 729
Standard deviation	13 790	3 977	2 846	20 026

Source: *Based on Statistical Information...*, op. cit.

Generally, prosecutor's offices resolved 1 303 840 criminal cases, 67% of which were Y_1, 18% – Y_2 and 15% – Y_3. The share of type Y_1 cases in the total number of cases ranged from 54% to 74%, of type Y_2 – from 10% to 26%, and of type Y_3 – from 6% to 33%. Descriptive statistics for the number of criminal cases resolved by the prosecutor's offices are presented in Table 3.

6. Analysis of the technical efficiency of the public organisational units of the prosecutor's offices

On the basis of the data concerning the inputs (variables X_1, X_2 and X_3) and outputs of the prosecutor's offices (variables Y_1, Y_2 and Y_3) in 2007, the authors calculated the clearance rate and technical efficiency measures defined for the proposed model by means of three DEA input oriented models: CCR, BCC and NIRS.

Table 4 presents statistics for the obtained efficiency measures for the examined prosecutor's offices.

Table 4. Basic statistics for the obtained efficiency measures

Descriptive statistics	Clearance rate	*ecrs*	*evrs*	*enirs*
Minimum	177	73%	77%	73%
Maximum	260	100%	100%	100%
Arithmetic mean	216	90%	95%	91%
Median	218	91%	97%	91%
First quartile	201	84%	91%	86%
Third quartile	227	96%	100%	100%
Standard deviation	19	8%	6%	8%

Source: Authors' own study.

On average, in 2007 the lowest clearance rate was obtained by the prosecutors of the Suwałki region (177 cases). In this district the technical efficiency measures calculated according to the DEA method were: *ecrs* = 73.04%, *evrs* = 100%, *enirs* = 73.04%. The highest Clearance rate (260 cases) was observed in the Wrocław region, where all the efficiency measures reached 100%. The Pearson coefficient of correlation between the clearance rate and the ecrs technical efficiency measure was 0.79. This is statistically significant at the $\alpha = 1\%$ level.

Table 6 shows to which of the types presented in Table 1 the individual objects belong.

Table 6. Affiliation of the analyzed prosecutor's offices to one of the object types defined by comparing individual efficiency measures

Type	Number of prosecutor's offices	Prosecutor's Office
I	9	Białystok, Olsztyn, Gliwice, Cracow, Siedlce, Sieradz, Wrocław, Opole, Świdnica
II	7	Łomża, Suwałki, Słupsk, Konin, Krosno, Przemyśl, Legnica
III	4	Warsaw, Gdańsk, Katowice, Poznań
IV	22	Ostrołęka, Płock, Bydgoszcz, Elbląg, Toruń, Włocławek, Bielsko, Częstochowa, Kielce, Nowy Sącz, Tarnów, Radom, Zamość, Kalisz, Piotrków Trybunalski, Zielona Góra, Rzeszów, Tarnobrzeg, Szczecin, Gorzów, Koszalin, Jelenia Góra
VI	3	Warsaw-Praga, Lublin, Łódź

Source: Authors' own study

When efficiency was evaluated by means of overall cost efficiency (the *ecsr* measure), 9 regional prosecutor's offices were considered to be efficient. On the other hand, the least efficient offices were: Suwałki (73.04%), Tarnobrzeg (75.62%), Ostrołęka (76.59%), Kielce (77.17%) and Włocławek (77.44%). The study results indicate that in 36 regions expenditure could be reduced by an average of 12.63% while maintaining the existing number of concluded cases.

The measures of pure cost efficiency (the *evsr* measure) indicate that 20 prosecutor's offices operated effectively. The least effective were the following offices: Kielce (77.22%), Bydgoszcz (80.85%), Warsaw-Praga (84.30%), Toruń (85.26%) and Zamość (85.89%). The study results show that an average saving of 9.34% is possible in 25 regions.

Analysis of the economy of scale led to the additional conclusion that in 11 units the reason for their inefficiency was their inappropriate scale of operation (these regions were either too small or too big). The former group (too small) included the Łomża, Suwałki, Słupsk, Konin, Krosno, Przemyśl and Legnica regions. The latter group (too big) consisted of the Warsaw, Gdańsk, Katowice and Poznań regions.

7. Analysis of the cost efficiency of the public organisational units of the prosecutor's offices

On the basis of data concerning 2007 expenditure and the output of the prosecutor's offices, the authors calculated the average case cost index and the cost efficiency measures defined for the proposed model by means of three input oriented DEA models: CCR, BCC and NIRS.

Table 7 shows statistics for the obtained efficiency measures for the examined prosecutor's offices.

Table 7. Basic statistics for the obtained efficiency measures

Descriptive statistics	Average case cost index	ecrs	evrs	enirs
Minimum	PLN 576.29	68%	72%	68%
Maximum	PLN 1 051.13	100%	100%	100%
Arithmetic mean	PLN 789.40	87%	94%	88%
Median	PLN 789.24	85%	96%	88%
First quartile	PLN 724.31	79%	88%	80%
Third quartile	PLN 859.34	95%	100%	99%
Standard deviation	PLN 93.79	9%	7%	10%

Source: Authors' own study.

The lowest average cost of a concluded case (PLN 576.29) was obtained in the Gliwice region. In this region the efficiency measures calculated by means of the DEA method were 100%. The highest average cost (PLN 1 051.13) was observed in the Suwałki region, where the *ecrs* was 68.28% (the lowest value), *evrs* = 100% and *enirs* = 68.28%. The Pearson coefficient of correlation between the average cost index and the cost efficiency measure was 0.8. This was statistically significant at the $\alpha = 1\%$ level.

Table 8 shows to which of the types presented in Table 1 the individual objects belong.

Table 8. Affiliation of the analyzed prosecutor's offices to one of the object types defined by comparing individual efficiency measures

Type	Number of prosecutor's offices	Prosecutor's Office
I	8	Białystok, Olsztyn, Gliwice, Cracow, Siedlce, Wrocław, Opole, Świdnica
II	6	Łomża, Suwałki, Słupsk, Sieradz, Krosno, Przemyśl
III	3	Warsaw, Gdańsk, Katowice
IV	23	Ostrołęka, Płock, Elbląg, Toruń, Włocławek, Bielsko, Częstochowa, Kielce, Nowy Sącz, Tarnów, Radom, Zamość, Kalisz, Piotrków Trybunalski, Konin, Zielona Góra, Rzeszów, Tarnobrzeg, Szczecin, Gorzów, Koszalin, Jelenia Góra, Legnica
VI	5	Warsaw-Praga, Bydgoszcz, Lublin, Łódź, Poznań

Source: Authors' own study.

When efficiency was evaluated by means of overall cost efficiency (the *ecsr* measure), 8 regional prosecutor's offices were considered to be efficient. The least efficient offices were: Suwałki (68.28%), Włocławek (70.84%), Kielce (71.16%), Toruń (73.39%) and Ostrołęka (73.77%). The study results indicate that in 37 regions expen-

diture could be reduced by an average of 15.75% (a total of PLN 117,792,377) while maintaining the existing number of concluded cases.

The measures of pure cost efficiency (the *evsr* measure) indicate that 17 prosecutor's offices operated effectively. The least effective were the following offices: Kielce (71.87%), Bydgoszcz (79.23%), Toruń (82.47%), Szczecin (83.87%), Warsaw--Praga (84.30%). The study results show that an average savings of 10.11% (a total of PLN 58 753 908) are possible in 28 regions.

Analysis of the economy of scale led to the additional conclusion that in 9 regions the reason for their inefficiency was their inappropriate scale of operation (the regions were either too small or too big). The former group (too small) included the Krosno, Legnica, Łomża, Przemyśl, Sieradz, Suwałki and Słupsk regions. The latter group (too big) consisted of the, Warsaw, Gdańsk and Katowice regions.

8. Comparison of the results obtained

The evaluation of cost efficiency is very similar to the results obtained using the model applied to evaluate technical efficiency. Pearson's coefficient of correlation between the average cost of concluded cases and the clearance rate was 0.85, while the coefficients of correlation between efficiency measures were respectively: *ecrs* (0.92), *evrs* (0.95) and *enirs* (0.93).

In both cases individual prosecutor's offices were predominantly affiliated to the same types of objects as defined by comparing individual efficiency measures. Only five regional prosecutor's offices differed in this matter.

Table 9. Affiliation of the analyzed prosecutor's offices to one of the object types defined by comparing individual cost and technical efficiency measures

Cost efficiency	Technical efficiency					
	I	II	III	IV	IV	**Total**
I	8	0	0	0	0	**8**
II	1	5	0	0	0	**6**
III	0	0	3	0	0	**3**
IV	0	2	0	21	0	**23**
VI	0	0	1	1	3	**5**
Total	**9**	**7**	**4**	**22**	**3**	**45**

Source: Authors' own study.

The differences observed result from the fact that compared with the analysis of technical efficiency, the evaluation of cost efficiency takes into consideration not only

the number of factors used in the production process, but also their cost. For example, the Włocławek prosecutor's office is technically efficient and cost inefficient by 29.16%. In this region the average salary of prosecutors is PLN 8000, while the national average is PLN 7340. The reverse situation can be observed in the Gliwice prosecutor's office, which is technically inefficient at a level of 24.39% and cost efficient at the same time. In this region the average cost of concluded cases is the lowest and the average salary of prosecutors is PLN 6570.

The average salaries of prosecutors differ significantly from region to region due to their different average length of service, as well as differences between the number of prosecutors granted a functional allowance (which in turn is determined by the number of district prosecutor's offices in a given region, as well as by their size) and the total number of prosecutors employed in a given region. For example, the Włocławek region consists of 5 district prosecutor's offices where 43 prosecutors are employed (an average of 8.6 per office). Knowing that in each of the offices about 3 prosecutors receive a functional allowance, we can estimate that on average 15 (35%) of them are given such an allowance. The Gliwice region consists of 11 district prosecutor's offices employing 150 prosecutors (an average of 13.64 per office). Therefore, the estimated number of prosecutors who receive a functional allowance is 33 (22%).

9. Conclusion

When examining the efficiency of public sector units, the DEA method gives the opportunity of taking in account many inputs and outputs in the analysis. Additionally, if we include the economy of scale and the results of the comparative analysis of technical and cost efficiency in our considerations, we obtain useful information about the structure of the public organizational units of Polish prosecutor's offices.

The DEA method is particularly useful in the comparative analysis of units providing the same type of services, e.g. the ones presented in this study. It enables an evaluation of potential savings in their resource management. The results of the DEA method can also be used in an output oriented budgeting process when deciding on the allocation of budget funds and defining a unit's optimal size.

Further research into the operation of public organizational units of the prosecutor's offices should be supplemented with a detailed analysis of the effect of the structure of outputs on their efficiency, an analysis of how substituting inputs influences efficiency [12] and an analysis of the effectiveness of prosecutor's offices.

References

[1] AFONSO A., AUBYN S.M., *Non-parametric Approaches to Education and Health Expenditure Efficiency in OECD Countries*, Technical University of Lisbon, 2004.

[2] AFONSO A., SCHUKNECHT L., TANZI V., *Public Sector Efficiency: Evidence for New EU Member States and Emerging Markets*, European Central Bank Discussion Paper, 2006, No. 581.

[3] AZEVEDO P.A., YEUNG L., *Beyond Conventional Wisdom and Anecdotal Evidence: Measuring Efficiency of Brazilian Courts*, ISNIE Working Papers Series, 2009. http://extranet.isnie.org/uploads/isnie2009/yeung_azevedo.pdf

[4] CHARNES A., COOPER W.W., HUANG Z.M., SUN D.B., *Polyhedral cone-ratio DEA models*, Journal of Econometrics, 1990, No. 46.

[5] CHARNES A., COOPER W., LEWIN A.Y., SEIFORS L.M. (ed.), *Data Envelopment Analysis – Theory, Methodology, and Applications*, Norwell: Kluwer Academic Publishers, 1994.

[6] DEBREU G., *The Coefficient of Recourse Utilisation*, Econometrica, July 1951, 19 (3).

[7] DOMAGAŁA A., *Metoda Data Envelopment Analysis jako narzędzie badania względnej efektywności technicznej*, Badania Operacyjne i Decyzje, 2007, No. 3–4.

[8] FÄRE R., GROSSKOPF S., LOVELL C.A.K., *Production Frontiers*, Cambridge University Press, Cambridge, 1994.

[9] FARRELL M.J., *The Measurement of Productive Efficiency*, Journal of the Royal Statistical Society, 1957, No. 120.

[10] FRIED H.O., LOVELL C.A.K., SCHMIDT S., *The measurement of productive efficiency. Techniques and applications*, Oxford University Press, New York, 1993.

[11] GORMAN M., RUGGIERO J., *Evaluating U.S. judicial district prosecutor performance using DEA: are disadvantaged counties more inefficient?*, European Journal of Law and Economics, Springer, 2009, Vol. 27(3), 275–283.

[12] GUZIK B., *O pewnej możliwości uwzględnienia substytucji nakładów w modelach DEA*, Badania Operacyjne i Decyzje, 2007, No. 3–4.

[13] HAGSTEDT K., PROOS, J., *Has the recent restructuring of the Swedish district courts improved efficiency? A DEA analysis*, Uppsala University, Department of Economics; Spring, 2008.

[14] KITTELSEN S., FORSUND F., *Efficiency Analysis of Norvegian District Courts*, The Journal of Productivity Analysis, 1992, No. 3, 277–306.

[15] LEWIN A.Y., MOREY R.C., COOK, T.J., *Evaluating the Administrative Efficiency of Courts*, Omega 1O, 1992, 401–441.

[16] MARSELLI R., VANNINI M., *L'efficienza tecnica dei distretti di Corte d'Appello italiani: aspetti metodologici, benchmarking e arretrato smaltibile*, Working Paper CRENoS 200409, Centre for North South Economic Research, University of Cagliari and Sassari, Sardinia, 2004.

[17] NAZARKO J., KOMUDA M., KUŹMICZ K., SZUBZDA E., URBAN J., *Metoda DEA w badaniu efektywności instytucji sektora publicznego na przykładzie szkół wyższych*, Badania Operacyjne i Decyzje, 2008, No. 4, 89–105.

[18] NAZARKO J., URBAN J., KOMUDA M., KUŹMICZ K., SZUBZDA E., *Metoda DEA w ocenie efektywności funkcjonowania podmiotów sektora publicznego*, Wydawnictwo Format, Wrocław, 2008.

[19] OWSIAK S., *Finanse publiczne. Teoria i praktyka*, PWN, Warszawa, 2005.

[20] PEDRAJA-CHAPARRO F., SALINAS-JIMENEZ J., *An Assessment of the Efficiency of Spanish Courts Using DEA*, Journal of Applied Economics, 1996, No. 28.

[21] ROGOWSKI G., *Metody działalności banku na potrzeby zarządzania strategicznego*, Wydawnictwo WSB w Poznaniu, Poznań, 1998.

[22] SCHNEIDER M.R., *Judicial Career Incentives and Court Performance: An Empirical Study of the German Labor Courts of Appeal*, European Journal of Law and Economics, 2005, No. 20.

[23] SEIFORD L.M., THRALL R.M., *Recent Developments in DEA The mathematical Programming Approach to frontier Analysis*, Journal of Econometrics, 1990, No. 46.
[24] *Sektor publiczny w Polsce i na Świecie. Między upadkiem a rozkwitem*, pod red. Kleera J., Wydawnictwo Naukowe Cedetu PL, Warszawa, 2005.
[25] SOUZA M.C.S., SCHWENGBER S.B., *Efficiency Estimates for Judicial Services in Brazil: Nonparametric FDH and the Expected Order-M Efficiency Scores for Rio Grande do Sul Courts*, Meeting ANPEC 2005.
[26] SPOTTISWOODE C., *Improving Police Performance: A New Approach to Measuring Police Efficiency*, HM Treasury Public Services Productivity Panel, London, 2000.
[27] STIGLITZ J.E., *Ekonomia sektora publicznego*, PWN, Warszawa, 2004, 149–161.
[28] STONE M., *How not to measure the efficiency of public service (and how one might)*, Journal of the Royal Statistical Society A, 2002, Vol. 165, issue 3.
[29] *System finansów publicznych w Polsce*, pod red. Pietrzak B., Polański Z., Woźniak B., PWN, Warszawa, 2008, T. 2.
[30] VAN DEN EECKHAUT P., TULKENS H., JAMAR M., *Cost efficiency in Belgian municipalities*, [in:] Fried, C. Lovell, S. Schmidt (eds.) *The Measurement of Productive Efficiency: Techniques and Applications*, Oxford Univ. Press, New York, 1993.
[31] WHEELOCK C., WILSON P.W., *Evaluating the Efficiency of Commercial Banks: Does Our View of What Banks Do Matter?*, Review of Federal Reserve of St. Louis, July/August, 1995.