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Measurement of expenditure efficiency of Polish cities with county rights in the context of quality of life

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Abstract

The article is devoted to the measurement of efficiency of overall expenditures. The purpose of the study is to evaluate the efficiency of use of budget resources by local government units in the context of fostering quality of life. The subject of the study is 65 Polish cities with county rights (county status). Calculations were carried out using Data Envelopment Analysis (DEA). The results of analysis confirm the two research hypotheses: the efficiency of budget expenditures is higher in larger cities with county rights (status), and the efficiency of budget expenditures is higher in cities with county rights (status) with lower overall per capita expenditures.

Keywords: efficiency, budget expenditures, Data Envelopment Analysis, DEA, cities with county rights, cities with county status.

Introduction

The subject of local government finances encompasses issues related to the rationality of public fund management that include processes of collection and expenditure of these funds by local government bodies. An expenditure policy should be governed by the criteria of rationality and efficiency of public and social task performance. One of these criteria – efficiency – is examined in this article.

Cities with county rights (status) in the structure of Polish local government

Polish local government has been functioning on three levels since 1999: commune (gmina), county (powiat) and region (voivodeship). A commune is the fundamental local government unit, while a county has the status of a local unit performing tasks that exceed the competences of communes. With respect to the nature of the localities that make up a commune, they are divided into three types: urban, rural and urban-rural. Some urban communes, i.e. of the first type, have a specific status: one administrative centre performs both commune and county tasks. Formally, they are referred to as cities with county rights. Their overall revenue consists of revenues derived from performing both commune tasks and county tasks. Cities with county rights do not form a separate level of local government or a fourth type of commune. However, because of their distinctive functional, demographic, urban, administrative and economic features, they are often considered a separate category in statistics. Cities with county rights are also known as county-free cities (Kuhlmann 2010). They exist in a number of European countries, such as France, Norway, Spain and Hungary (Pickvance 2002). Examples of cities with county rights include Dresden, Schwerin and Munich in Germany (*kreisfreie Städte*), Innsbruck and Graz in Austria (*Statutarstädte*), Oslo in Norway, and Paris in France (Sekuła 2015).

The concept of efficiency and urban quality of life

The concept of efficiency can be differently defined. For the purpose of further considerations, Farrell's concept of technical efficiency is adopted as a measure describing the ratio of the output produced from the input to the maximum output possible to achieve in the specific circumstances and using a particular technology (Farrell 1957). On this basis, we can say that technical inefficiency describes a situation where more input is used than necessary to achieve a particular output level or the output produced is below the output capabilities for a particular input level.

With respect to economic and research practice, the concept of efficiency is treated strictly quantitatively. However, in view of the emphasis placed on the rationalisation of public spending, it is reasonable to give particular attention to the qualitative aspects of actions undertaken using public funds. This aspect directly relates to the concept of quality of urban life as strictly connected with the perception and subjective experiences of people.

Quality of urban life is defined as the relationship between the perceptions and feelings of residents and their own experiences relating to the space they inhabit (Senlier et al. 2008). A comprehensive explanation of this term is connected with such concepts as "satisfaction", "personal growth" and "well-being". Because it often refers to a specific place, in the case of cities it is referred to as the urban quality of life (Marans 2015). The quality of life in a particular area can be analysed in the context of its two main dimensions – objective and subjective. Studies focusing on the objective dimension are chiefly based on socio-economic indicators that can be used to present the achievements and shortcomings in certain component areas of quality of life (Liao 2009).

There are many publications devoted to the problem of selection of areas for analysis to evaluate quality of life. In the most general sense, it is thought that quality of life is affected by cultural, social, economic, environmental and even personal factors. The choice of factors taken into account depends on the type of quality of life to be measured (urban, rural, general) and the relevant geographical area. There are sets of factors relating to urban life in general, i.e. without geographical constraints (Marans 2015), considering the specific character of European cities (Senlier et al. 2008) or European functional regions (Cheshire and Magrini 2006) or US metropolitan areas (Shapiro 2006). The areas selected for this study are the seven areas proposed by P. Liao (2009).

The determination of the areas for analysis is as important as the selection of appropriate methods of efficiency evaluation. The literature devoted to this subject identifies the following methods, as required: classical, parametric and non-parametric. Non-parametric methods use mathematical programming, and, unlike the previous category, they do not make it necessary to consider the effect of random factors or measurement errors or to make assumptions as to the functional relationship between inputs and outputs. The original non-parametric method of efficiency evaluation is DEA.

Data Envelopment Analysis

Data Envelopment Analysis (DEA) is a non-parametric method for evaluating relative efficiency, based on linear programming and referring to the construction of production function as empirical data envelopment (Charnes et al. 1978), drawing on Farrell's concept (Farell 1957).

The determination of efficiency involves solving a mathematical decision-making problem. It consists of identifying reference observations among the set of objects analysed and comparing the other objects to them. Thus, DEA is said to evaluate the relative efficiency of decision-making units (DMUs). The units are "decision-making" because they have an impact on the level of resources incurred (inputs) and results obtained (outputs). The efficiency of DMUs that, from the point of view of the production process, are best

at transforming inputs into outputs and therefore are situated at the best practice frontier, is given the value 1, whereas the efficiency of other, less efficient units is less than one.

DEA makes it possible to find the causes of inefficiency and determine the directions of input or output changes enabling inefficient units to achieve maximum efficiency. The distinguishing feature of DEA is the capability of examining objects that transform multiple inputs into multiple outputs. The application of DEA does not require attaching weights to the individual inputs and outputs as measures of significance or making assumptions as to the functional relationship between the variables (Cooper et al. 2007). Unfortunately, DEA is highly sensitive to outliers (atypical data) describing efficient units, which may lower the efficiency results for the remaining objects. When using the most basic DEA models, redundancy of efficient objects may sometimes be observed. To ensure reliability of analyses conducted using DEA, it is necessary to adhere to specific assumptions and limitations, which will be described in the methodological section.

Application of DEA in evaluation of the efficiency of local government expenditures – a literature review of the results of previous research

There are many studies examining local government expenditures all over the world. Analyses conducted by Kalb et al. are regarded as being among the first studies devoted to the efficiency of German local government units. The study covered more than 1000 municipalities of the German state of Baden-Württemberg. The data for 2004 were used, and the inputs were the total current expenditures, net, i.e. excluding the capital expenditures. The study employed four areas: the social, educational, recreational and infrastructural spheres (Kalb et al. 2012).

Geys and Moesen measured the efficiency of local government units using the non-parametric methods DEA and FDH (Free Disposal Hull), as well as econometric techniques (stochastic approach). The study was carried out based on data for 2000 collected from 304 Flemish municipalities and was intended to compare different measurement methods. The authors pointed out that many analyses concerning the efficiency of local governments focus on a single area, and therefore cannot be used as a basis for comprehensive evaluation. Total current expenditures were selected as the input variable. The outputs were measures in five areas, i.e. the social, educational, recreational, infrastructural and environmental spheres (Geys and Moesen 2009).

Another study assessed the efficiency of local government units in Brazil. The analysis used data for 2001 obtained from nearly 4,800 Brazilian municipalities. Calculations were made using the FDH approach and different variants of DEA. The study employed 4 inputs representing 3 categories: total costs, personnel and public services, and 11 outputs from the communal service areas relating to administration, education and health and housing conditions. The results obtained indicated a link between the municipality size and its efficiency rating. The analyses suggest that smaller municipalities are less efficient than larger ones. There could be different reasons why the efficiency increases with municipality size. The authors point out that the economies of scale could explain this effect in large units (Sousa and Stošić 2005).

The efficiency of the municipal sector was also investigated in Spanish region Murcia. Data for 2000–2002 were collected from 31 units. The following spheres were analysed: green spaces, water supply, waste collection, police, culture and sport. The results revealed a positive correlation between efficiency and the following determinants: economic level, size of the municipality, decentralisation, political sign and financial situation (Benito et al. 2010).

Study conducted in Finland, focused on the cost efficiency of basic service provision by municipalities. The data were collected from 353 Finnish municipalities and covered the period 1994–2002. A two-stage approach was employed in the study. The first stage involved calculation of efficiency, and in the second stage regression models were applied to explain the obtained efficiency scores. While only a single input

was used throughout the study – aggregate net cost of provision – the outputs included between 6 and 10 constituent basic municipal services. The cost efficiency median was 87.2%, with a minimum value of 62% (Loikkanen and Susiluoto 2005).

A combination of the DEA method and parametric analysis was also used in the evaluation of efficiency of Portugal municipalities. The study included estimation and analysis of expenditure efficiency for 278 clustered continental municipalities. The study was based on data for 2001. The input was per capita expenditure, whereas the output was a composite indicator referred to as the Local Government Output Indicator (LGOI). It consisted of sub-indicators referring to municipal service provision in the following areas: social services, education, cultural services, sanitary services, territory organisation and road infrastructure. The results obtained led to the conclusion that most municipalities can improve their efficiency without increasing budget expenditures. The second stage of the research was intended to explain the distribution of efficiency results. The following factors contributing to efficiency improvement were identified: education, municipal per capita purchasing power and the distance from the district capital (Afonso and Fernandes 2008).

Analyses carried out for Turkish municipalities employed a combination of DEA and Grey Relation Analysis (GRA). The analysis covered 14 metropolitan municipalities. The data collected applied to the year 2011. In the first stage carried out using the DEA model, a set of 3 inputs (current expenditures, investment expenditures and transfer expenditures) and 3 outputs (tax revenues, non-tax revenues and the revenues obtained from aid and funds) was used. Then the municipalities identified as efficient were sequenced by the GRA method (Kaygisiz Ertuğ and Girginer 2015).

An article concerned with the efficiency of Italian local government presents the results of research evaluating the expenditure efficiency of the 103 largest Italian cities on the basis of data for 2011. The inputs consisted of annual expenditures in 9 areas, including municipal waste management, public transport or cleaning services. The outputs covered 5 areas: urban infrastructure development, urban ecosystem quality, kindergartens, municipality area extension, and the number of residents. The results obtained indicate a probable impact of economies of scale on efficiency. It was additionally noted that uncontrollable environmental variables, the decision-making process complexity and managerial skills may have a stronger effect on the efficiency of large cities than their size alone (lo Storto 2013).

Efficiency of local government expenditures was also investigated in a group of 37 large cities (with a population exceeding 100,000) in Poland. The time frame of analysis was the period between 2009 and 2013. The input consisted of total expenditures per resident, whereas the outputs included values representing the areas of health care, household finances, labour market, education, leisure and recreation, public safety and environmental protection. The analysis proved that an increase in efficiency is promoted by the proximity of other units which offer cooperation possibilities, but also exert competitive pressure. It was demonstrated that budget expenditure efficiency in the large city category is greater in cities that have smaller populations and lower per capita expenditures (Sekuła and Julkowski 2015).

In Poland, the research was carried out on the subject of the efficiency of local governments' expenditures on public and merit goods at the communes' level. The analysis using DEA and Tobit regression covered the years 2002-2006 and three fields: education, environmental protection and public administration. The results prove that communes with higher population and revenues tend to be more efficient, whereas small rural ones are generally less efficient (Karbownik and Kula 2009).

Other research on the area of Poland evaluated the efficiency of investment activity in the communes in Poland on rural areas. The inputs and the effects of investment activity of rural and urban-rural communes in the years 2007-2013 were compared. The studies showed that the amount of expenditure incurred on the studied spheres of investment activity does not translate into their efficiency. This was connected with the

possibility of obtaining additional funds from EU, which were not included in the study (Kobiałka and Kubik 2017).

In other studies devoted to efficiency of capital expenditures of Polish municipalities in the Westpomeranian Region it was shown a link between the size and specificity of the entity, and the level of efficiency of its spending for investment. The lowest level of efficiency ratio carried small territorial units - rural profile generally. The article evaluated the efficiency between 2004–2009 using the DEA method (Zioło 2012).

Research methodology

Selection of units (sample)

This study examines 65 cities with county rights, which constitute the DMUs. This category includes all province capitals as well as cities that have a relatively large impact on the surrounding area. Hence, they are often referred to as "local capitals" even if they are not administrative capitals of regions. From the statistical viewpoint they are classified at both NUTS-5 and NUTS-4 levels. When investigating the expenditure efficiency of such units, it is therefore possible to take into account both commune and county tasks.

One of the fundamental assumptions of DEA is that the set of units to be analysed should be a homogeneous group (Domagała 2007), to avoid comparing inherently different objects. Therefore, Warsaw was excluded from the study, since it performs the tasks of the state capital in addition to commune and county responsibilities. Taking into account the basic homogeneity criteria concerning the similar nature of activities and tasks performed, equal access to resources and functioning in comparable environments (Dyson 2001), the cities with county rights included in the study are a homogeneous group.

Selection of variables

Keeping in mind the purpose of this study the total expenditures [PLN] per resident were selected as the input (I). To identify the measures enabling evaluation of the efficiency of public funds spending by local government units, quality of life indicators can be employed and these were used to determine the results. For this purpose, indicators (Tab. 1) were selected within the areas suggested by P. Liao (2009) to reflect the characteristics of these areas.

The figures used in the study were sourced from the Local Data Bank. Mean values for the 2010–2014 period were applied to ensure an objective character of the measures used. Two exceptions are the O5 and O6 indicators, available at NUTS-4 level only for the 2012–2014 period.

Table 1: Output indicators representing quality of life areas

Symbol	Area	Indicator
O1	Medical services	Number of beds in general hospitals [per 10,000 residents]
O2	Domestic finances	Mean gross monthly salary [per resident]
O3	Work	Proportion of employed people in the working age population [%]
O4	Education	Number of students awarded the secondary school leaving certificate out of the total number of exam takers [%]
O5	Leisure	The area of sport and leisure areas out of the total survey area [%]
O6	Public safety	Crimes confirmed in completed pre-trial criminal proceedings [%]
O7	Environmental quality	Purified sewage [dam^3/100 km^2]

Source: Own calculations

The set of variables selected meets the uniform preference trend condition, i.e. an increase of output will be considered favourable, whereas an increase of input with constant output will be regarded as undesirable. The results of the analysis indicating a low correlation between the variables confirm the possibility of using the selected indicator set in further investigations.

Model selection

There are numerous DEA models available, meeting different analysis needs (see Cook and Seiford 2009). The most common, basic models include CCR (short for the names Charnes, Cooper and Rhodes), assuming constant returns to scale (Charnes et al. 1978), and BCC (short for the names Banker, Charnes and Cooper) with variable returns to scale (Banker et al. 1984). When these models are used, the maximum efficiency (equal to 1) is usually achieved by more than one DMU, which limits the possibility of comparing efficient units. To remedy this shortcoming, P. Andersen and N. Petersen developed the super-efficiency model, where a ranking of efficient DMUs can be created by assigning to them efficiency scores greater than 1 (Andersen and Petersen 1993). The aforementioned models are of the radial type, assuming a proportional change of inputs and outputs. Because of this, they do not take into account deficiencies in the form of slacks, while allowing zero weights (measures of significance) within inputs and outputs, which in turn may lead to a situation where some variables are not included in the determination of the efficiency score of a particular DMU.

For the purpose of this study, to enable full comparison, including between efficient DMUs, while taking into account the significance of all inputs and outputs, the authors decided to use the Super Slacks Based Measure (Super SBM) proposed by K. Tone (2002), which, assuming constant returns to scale and an input-oriented approach, is expressed as follows:

$$\min \delta = \frac{1}{\frac{1}{s}\sum_{r=1}^{s} \bar{y}_r / y_{r0}}$$

subject to:

$$\bar{x} \geq \sum_{j=1,\neq 0}^{n} \lambda_j x_j$$

$$\bar{y} \leq \sum_{j=1,\neq 0}^{n} \lambda_j y_j$$

$$\bar{x} = x_0, \qquad \bar{y} \leq y_0, \qquad y_0 \geq 0, \qquad \lambda \geq 0$$

The model orientation is an important feature relating to inputs and outputs. An input-oriented model aims to minimise the inputs incurred while assuming constant outputs, whereas an output-oriented model maximises the outputs given a constant level of inputs (Cooper et al. 2007). In view of the fact that local government units, by appropriate adjustment of their policies, have a greater potential to maximise the results of their activities than to directly influence the resources they have at their disposal, an output-oriented model was adopted. Therefore, further considerations are based on the assumption of constant budget expenditures per resident and the objective of maximising performance results that enhance the living conditions and quality of life.

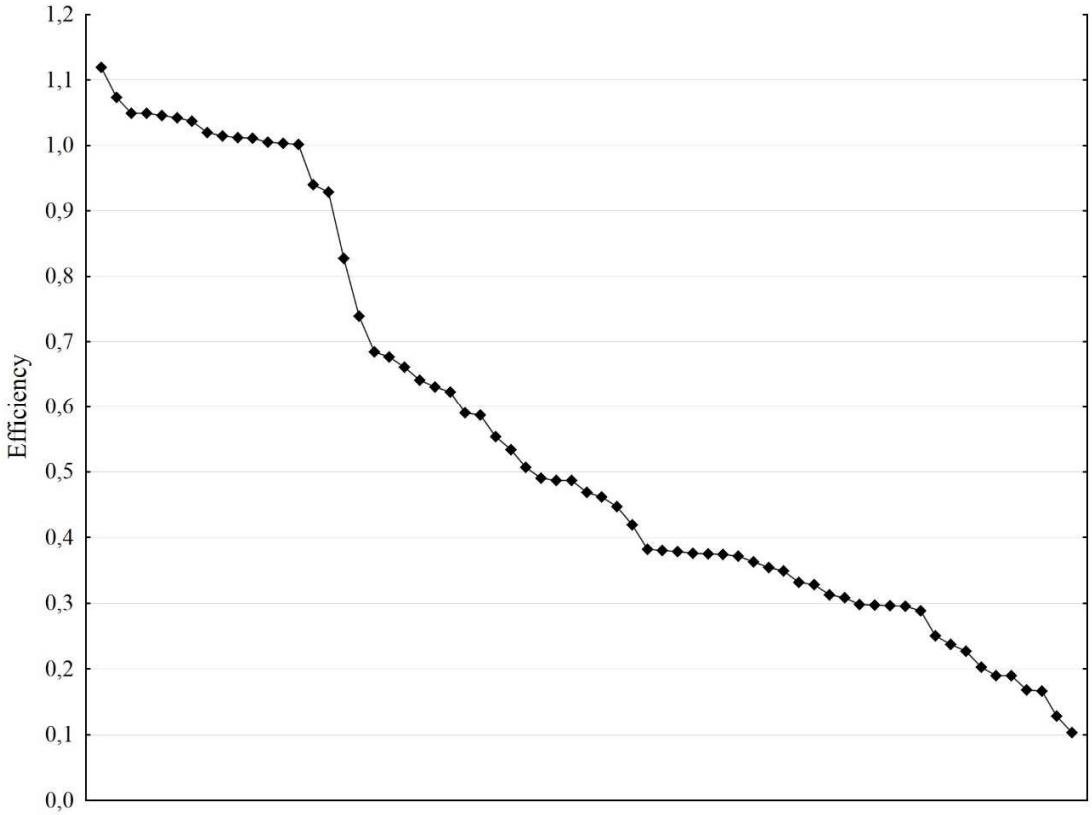

Fig 1. Distribution of efficiency scores

Source: Own calculations

Calculation and results

Calculations were made using MaxDEA Ultra 6.11 software. Calculation results suggest that the efficiency scores of the units investigated range between 0.103 and 1.119, and the mean score is 0.557. Fourteen cities out of 65 DMUs were rated as efficient. As regards the remaining (inefficient) ones, a remarkable fact is that only 4 cities achieved a score between 0.7 and 1, as shown in Fig. 1. Thus, there is a clear division between the efficient and inefficient units. Most of the inefficient units attained a score between 0.289 and 0.685.

All the 14 efficient cities with county rights and the same number of least efficient units with their efficiency scores are presented in Tab. 2. Eight out of the 14 efficient units, i.e. more than half, are situated in the Upper Silesian metropolitan area. One of them is Katowice – the capital of the Silesian Province, where the aforementioned metropolitan area is located and winner of a national quality of life ranking created by the Polish edition of Newsweek magazine. It could be proposed that the proximity of urban centres that cooperate and compete with each other contributes to the higher efficiency. This concept, known as the cluster theory, is widely known and well-grounded in theory and practice, although mainly with respect to businesses (e.g. Engel 2015).

Table 2: Efficiency scores of the budget expenditures of Polish cities with county rights – the most and least efficient units

Rank	DMU	City	Efficiency	Rank	DMU	City	Efficiency
1	DMU17	Chorzów	1.119	52	DMU3	Skierniewice	0.298
2	DMU3	Kraków	1.074	53	DMU5	Radom	0.296
3	DMU13	Piekary Śląskie	1.049	54	DMU48	Koszalin	0.296
4	DMU23	Jastrzębie-Zdrój	1.049	55	DMU4	Ostrołęka	0.289
5	DMU18	Katowice	1.046	56	DMU53	Wałbrzych	0.250
6	DMU22	Świętochłowice	1.043	57	DMU39	Łomża	0.237
7	DMU56	Bydgoszcz	1.037	58	DMU63	Sopot	0.227
8	DMU28	Sosnowiec	1.020	59	DMU2	Piotrków Trybunalski	0.203
9	DMU11	Bielsko-Biała	1.014	60	DMU26	Dąbrowa Górnicza	0.190
10	DMU34	Krosno	1.012	61	DMU25	Żory	0.190
11	DMU47	Poznań	1.011	62	DMU40	Suwałki	0.168
12	DMU30	Biała Podlaska	1.005	63	DMU62	Gdynia	0.166
13	DMU54	Wrocław	1.004	64	DMU50	Świnoujście	0.128
14	DMU21	Siemianowice Śląskie	1.002	65	DMU37	Tarnobrzeg	0.103

Source: Own calculations

The capitals of provinces in the south and west of Poland are also efficient units. This suggests a potential link between the unit's location in the European area and its efficiency level, which was also noted in the Finnish study (Moisio and Uusitalo 2013). Meanwhile, inefficient units are characterised by relatively small populations, as presented in Fig. 2. It could be concluded from the graph that efficiency increases with increasing population, which confirms hypothesis 1. High efficiency is a feature of the largest Polish cities, such as Cracow, Wrocław, Poznań or Katowice, as mentioned above. Based on a sample of 65 ob□rv□tio□, □po□itiv□, mod□r□t□li□□r r□l□tio□hip w□□obt□i□□d; th□□orr□l□tio□□o□ffi□i□□t of 0.3820 proved to be of high statistical significance (p<0.01). The studies quoted earlier also pointed to a similar r□l□tio□hip, whi□h □o□firm□th□□xi□t□□□□of □□o□omi□□of □□l□(lo □torto 2013; □ou□□□d □tošić 2005).

The second hypothesis is verified by demonstrating a relationship between efficiency and public expenditures per resident. It is of significance because the model analysed used total expenditure per resident as the input and assumed it to be constant while aiming to maximise the outputs, being the effects of activities resulting from local governments' expenditure policies, which was the basis for efficiency measurement. Based on the sample of 65 observations, a negative, moderate linear relationship was obt□i□□d; th□□orr□l□tio□□o□ffi□i□□t of -0.3525 proved to be of high statistical significance (p<0.01). These results are consistent with the findings of earlier studies examining a sample of large Polish cities (Sekuła and Julkowski 2015) and confirm hypothesis 2. This situation can be explained by more rational spending of resources where they are in shorter supply.

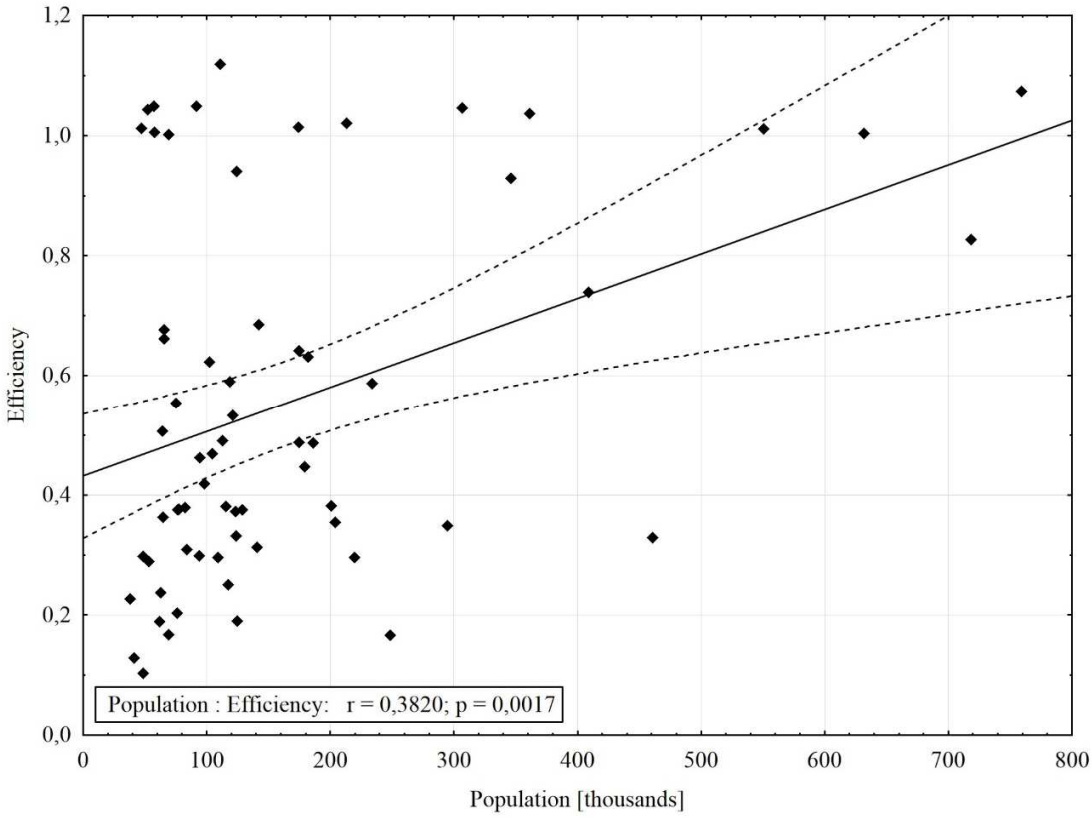

Fig 1. Scatter plot – Population (in thousands) : Efficiency

Source: Own calculations

Conclusions

An efficiency ranking of cities does not answer the question how inefficient cities could improve their situation. For management purposes, the position relative to other cities is of less importance, but it is useful to know in which areas and to what degree efforts should be concentrated to improve efficiency and manage the city's policy with a view to improving the quality of life. This information is provided by variable projection, which is obtained by solving the DEA model. The first obvious conclusion is that there is considerable diversity in the mean values of the desired magnitude of changes as well as in the maximum values in the individual areas. This indicates that the recommended magnitude of changes aimed at improving efficiency and the significance of the individual factors/areas show large differences.

The greatest mean deviation between the initial and projected values (magnitude of change), equal to 931%, was observed with respect to variable O5: *The area of sport and leisure areas out of the total survey area*. According to the DEA model calculations, the share of recreational areas relative to the total survey area for inefficient cities should range between 3.1% and 27.1% (given the present actual share in the range 0.49–8.58%). A far smaller mean magnitude of change (229%) was observed with respect to variable O6. *Crimes confirmed in completed pre-trial criminal proceedings*. The greatest projected percentage increase applies to the city of Sopot, struggling with the problem of multitudes of tourists in the holiday season. An average magnitude of change exceeding 100% (equal to 136%) is also observed in

the case of variable O7: *Purified sewage*. It applies to the natural environment area, which plays a major role in the improvement of the quality of life. Improvement of sewage treatment plant capacity is the responsibility of the commune authorities. In the remaining cases (O1, O2, O3, O4) the projected changes do not exceed 50% on average, and the values of standard deviations are not so significant

Summary, limitations and further research

The most important conclusions drawn from the research are as follows:

- an increase in efficiency is promoted by the vicinity of other units which offer cooperation possibilities, but also exert competitive pressure;
- the majority of the efficient cities with county rights are situated in the south-western part of Poland;
- the efficiency of budget expenditures is higher in larger cities with county rights (confirming the first hypothesis);
- the efficiency of budget expenditures is higher in cities with county rights where per capita expenditures are lower (confirming the second hypothesis);
- three out of seven result indicators (outputs) characterising the individual aspects of the quality of life – leisure, public safety and environmental quality – show a far higher mean magnitude of change, i.e. difference between the initial and projected values, than the remaining four indicators.

The conclusions drawn from the study focused on the investigation of the population of cities with county rights, and as such they are certainly of significance for the characterisation of such units as a group. Analysis focused on individual cities was not the purpose of this article.

It is necessary to bear in mind the relative character of DEA results, which entirely depend on the selected set of objects to be analysed and the defined set of variables. In this study, inefficiencies due to measurement errors, the presence of outliers, and other statistical discrepancies were not taken into account.

Further research into the area under discussion here should focus on the evaluation of changes in efficiency over time and identifying the factors determining such changes. Additionally, to enhance the objective character of the data representing the quality of life areas used as outputs, it is possible to use composite indicators, enabling a larger number of variables to be included in the analysis.

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