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## Efficiency Evaluation of Using Resources by Hospital Units

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### **Abstract:**

**Purpose:** The aim of this article is to present an efficient evaluation methodology for the hospital resources used in a study on units of healthcare system and their analysis in the organizational and legal forms.

**Design/Methodology/Approach:** A research group constituted 48 health care units has been used. For the empirical part, a non-parametric DEA method was used to evaluate the efficiency of functioning of hospital units (surgical and internal medicine, both public and private) for 2014-2018. All the units that were qualified to the study had a contracted hospital agreement.

**Findings:** Past analysis on the units of a healthcare system proved that efficiency of the usage of material or personal resources was underestimated and only a financial result was vital which in the units of healthcare system cannot play a major role. The authors proved that to manage efficiency it has to be previously measured with usage of the DEA method and the outcomes can be treated as a basis for developing and publishing detailed ranking lists that allow comparison between medical units. Results did not confirm that public health care units were less efficient than private units, which is very often taken as given.

**Practical Implications:** Presented results – together with a recommended method – apart from experimental virtue also have a huge practical value. They can be used in a process of benchmarking which is getting more important as one of modern managing conception and is easily used in a health care sector.

**Originality/Value:** Limitation of the resources in a system of health care determines necessity to constantly control the area of input-outcome. Conducted studies and conclusions constitute a new view on efficiency of health care units. The authors believe that it is necessary to continue studies in the regional field and also on different levels of protection systems.

**Keywords:** Health care, hospital, health service, DEA method, financing policy.

**JEL Codes:** JEL I18, H51.

**Paper Type:** Research Paper.

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## 1. Introduction

Health is a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity. The enjoyment of the highest attainable standard of health is one of the fundamental rights of every human being without distinction of race, religion, political belief, economic or social condition<sup>7</sup>. This is how World Health Organization determined a right of each human being to health care<sup>6</sup>. According to WHO individual and community health is influenced by e.g. access to and usage of health care understood as ‘organized actions of a defined system of health care service that assures a good state of health or give back in case it is lost and when it is impossible – minimizing effects of the disease and softening afflictions’<sup>5</sup>. The right to health care for Polish citizens is guaranteed by the Polish Constitution of May 3<sup>7</sup>.

From the conducted analyses of results of surveys prepared in 2018 by the Centre for Public Opinion Research<sup>8</sup>, based on a representative group of adult Polish citizens, it follows that:

- a system of health care functioning in Poland, after changes and long evolution since 1989, is still evaluated in a negative way. This evaluation was given by 66% surveyed, including 27% who has given a totally negative evaluation for health care functioning in Poland;
- the worst evaluation was given for access to appointments to specialists (83% of negative marks) and too few health professionals in hospitals (70%). (24%) of people surveyed claim that problems with accessibility and quality of service financed from public resources follows from inappropriate usage of funds.
- a negative view of the presented evaluations was enhanced by the fact that 57% of Polish citizens consider keeping good health as most important thing in life just after happiness in a family.

An evaluation of chosen elements of health care is conducted by the Supreme Audit Office every year which confirms that this area is a vital part of state functioning both for the authorities and the society. A report from the last control of health care system in Poland was presented by the Supreme Audit Office in May 2019.<sup>9</sup> This time the

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<sup>6</sup>See: *Konstytucja Światowej Organizacji Zdrowia, Porozumienie zawarte przez Rządy reprezentowane na Międzynarodowej Konferencji Zdrowia i Protokół dotyczący Międzynarodowego Urzędu Higieny Publicznej, podpisane w Nowym Jorku dnia 22 lipca 1946 r. (Dz. U. z 1948 r. Nr 61, poz. 477).*

<sup>7</sup>See: *Konstytucja Rzeczypospolitej Polskiej z dnia 2 kwietnia 1997 r. uchwalona przez Zgromadzenie Narodowe w dniu 2 kwietnia 1997 r., przyjęta przez Naród w referendum konstytucyjnym w dniu 25 maja 1997 r., podpisana przez Prezydenta Rzeczypospolitej Polskiej w dniu 16 lipca 1997 r. (Dz. U. 1997 Nr 78, poz. 483).*

<sup>8</sup>See: *Opinie na temat funkcjonowania opieki zdrowotnej. Komunikat z badań CBOP, Fundacja Centrum Badania Opinii Społecznej, Warszawa 2018, Nr 89, [https://cbos.pl/SPISKOM.POL/2018/K\\_089\\_18.PDF](https://cbos.pl/SPISKOM.POL/2018/K_089_18.PDF) [accessed on 05.05.2020].*

<sup>9</sup>See: *Raport: System ochrony zdrowia w Polsce – stan obecny i pożądane kierunki zmian. Informacja o wynikach kontroli, <https://www.nik.gov.pl/plik/id,20223,vp,22913.pdf> [accessed on 30.08.2019].*

study entailed the whole system of health care. In the report it was stated that: “*all the actions that had been taken so far did not bring expected results – quality improvement and better accessibility of health benefits. As it should be anticipated demographic and epidemiological conditioning will cause a growth of health care needs of the patients and an access to benefits, in case of no system changes, may get worse*”.

In the area of hospital health care, it was stated that:

- more than 50% of share costs of hospital treatment in health service costs which is financed by the National Health Fund systematically grows. Hospital treatment is the most expensive;
- diagnostics and patients' treatment are too often performed in hospitals instead of general practitioners and basic medical centres (as ambulatory care units);
- Poland among other countries of the European Union has one of the highest rates of the number of hospital beds for 100 thousand citizens;
- there is no reliable estimation of benefits, pertinent for the real costs incurred;
- cost intensity of health benefits is determined by remunerations of medical staff; which is then influenced by organization of work at medical units and high expectations of this occupational group. Employee claims additionally enhance pay rises of chosen groups of medical staff which are introduced through legal regulations and are financed from resources that are additionally submitted by National Health Fund. These pay rises were not linked with medical benefits; their quality or accessibility;
- benefit providers accomplished many investments, without recognizing the needs, such as: building or isolating, in organizational or venue terms operating theatre where capability overruns the needs of hospital departments and the number of contracted services with NHF; buying technical equipment; employing specialists and organizing specialized teams although such services were provided by other units in this area. These investment actions finally led to low usage of available resources, including hospital beds.

In the light of presented results from the survey and analyses of efficiency management of medical units (understood as efficiency of turning inputs into outcomes), it should be treated as priority especially with limited financial resources for health care, increasing cost intensity of medical services and the obligation to guarantee an access to benefits financed from public resources. The need to investigate and to improve efficiency of health care units<sup>10</sup> functioning is connected with a necessity to limit constant growth of costs. Improving efficiency of the units functioning should allow for proper activity of health care units in the future when a demand for medical benefits will additional grow due to occurring demographic changes (extending average lifetime and increasing a share of people in their adulthood in highly developed countries).

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<sup>10</sup>More in Ćwiakala-Malys Anna, Durbajło-Mrowiec Małgorzata, Łagowski Paweł *Diagnostyka efektywności wykorzystania zasobów leczenia szpitalnego Wrocław 2020 : Uniwersytet Wrocławski. E-Wydawnictwo. Prawnicza i Ekonomiczna Biblioteka Cyfrowa.*

It is estimated that an average share of health expenses (in a gross domestic product) in a group of countries that belong to the Organization for Economic Cooperation and Development (hereafter: OECD) doubled in the last 50 years<sup>11</sup>. However, in recent years dynamics of input increase for health care has speeded up. It happens due to already mentioned demographic changes but also due to a development of medical technologies or simply higher social expectations.

Polish health care system has been considered, especially by the patients, as unwieldy and inefficient<sup>12</sup>. In recent years, there have been and still are many attempts of changes that should improve the situation, nevertheless, until now none of the reforms has been introduced from beginning to end. A major problem is an increasing indebtedness of public units, in particular hospitals. In response to these challenges a bill was passed on medical activity on 15 April 2011<sup>13</sup>. It was supposed to improve functioning of the whole system by increasing efficiency at the lower level, that is a provider level. In mind of originators legal and organizational form of independent public health care units (hereafter: SPZOZ) is one of the reasons for inefficiency of health care system. A unit such as SPZOZ was admitted as a defective and inefficient legal form<sup>14</sup>, that is why it is necessary to change it to a different, well-adjusted to functioning in a market economy environment – originators believe that limited company would be the one.

For the needs of this article a following research hypothesis was made: SPZOZ are not less efficient organizational-legal forms than limited company<sup>15</sup>, in particular with reference to benefits offered. This assumption is, to a certain degree, a kind of denial of major causes of real difficulties in Polish health care system given as an explanation to a draft bill on health care services<sup>16</sup>. Efficiency measurement of analysed units from the Lower Silesia Province was conducted with usage of non-parametric DEA method on the basis of data form 2014-2018.

## **2. Efficiency Term**

Contemporarily a term ‘efficiency’ is very often used, in particular in terms of discourse between politicians, economists and entrepreneurs. Those interested in

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<sup>11</sup>*Evaluations on the basis of statistic data from OECD Available online:*

<http://stats.oecd.org/viewhtml.aspx?datasetcode=SHA&lang=en#> [accessed on: 30.06.2020].

<sup>12</sup>*Used statement appears in results of eg. Euro Health Consumer Index, which classifies Polish health care system on 32 place out of 35 analysed. A. Björnberg, Euro Health Consumer Index Report 2018, Health Consumer Powerhouse Ltd. 2019, p. 18; available online:*

<https://healthpowerhouse.com/media/EHCI-2018/EHCI-2018-report.pdf> [accessed on: 30.06.2020].

<sup>13</sup>*Ustawa z dnia 15 kwietnia 2011 r. o działalności leczniczej (Dz.U. 2011 nr 112 poz. 654).*

<sup>14</sup>*See: Sejm Rzeczypospolitej Polskiej VI Kadencji, Uzasadnienie do rządowego projektu ustawy o działalności leczniczej z dnia 15 października 2010 r., Druk sejmowy nr 3489.*

<sup>15</sup>*This research refers to efficiency study in its technical aspect, without quality factors. Unfortunately, in Poland we do not have enough data that would allow for conducting study on efficiency of particular units of health care in quality and quality-value context.*

<sup>16</sup>*Druk sejmowy nr 3489.*

health care system, particularly patients, can very often hear about the need for changes, in terms of actions that will lead to an improvement of efficiency. However, there are very rarely any attempts to define efficiency, to explain what is understood under this term.

Efficiency is characterized by ambiguity. *Polish dictionary* edited by Witold Doroszewski defines efficiency as ‘productivity, a positive result or efficacy’<sup>17</sup>. For a full understanding of this term it is necessary to refer to a context in which it is used. In economic literature many authors, for the need of their considerations, precisely described the term of efficiency, in other words they put emphasis on meanings in created, by themselves, definitions of efficiency (Table 1).

**Table 1.** Chosen explanations of efficiency term

Author	Definition
<b>Efficacy as condition/element of gaining efficiency</b>	
W. Gasparski (2007)	Economic activities should be capably preformed, that is efficiently – successfully and economically
S. Nowosielski (2008)	In a narrow meaning efficiency is identified with praxeological economic category, however, in a broad meaning component of efficiency are efficacy, favourability and economy
P.A. Samuelson, W.D. Nordhaus (1999)	Efficiency is using resources in the most effective way
<b>Efficiency as a criterion for evaluating effectiveness</b>	
T. Lubińska (2009)	Efficiency refers to a level of gaining aims with minimal costs or with gaining maximal level of the aims with given costs.
J.A.F. Stoner, R.E. Freeman, D.R. Gilbert (2002)	Efficiency is a measure of effectiveness, a measure to what degree stated aims are gained
H. Zadora (2002)	Efficiency is a quantification of effectiveness
<b>Effectiveness and efficiency as two independent categories</b>	
L. Białoń (1995)	An entrepreneurship can be efficient and effective, efficient and ineffective, inefficient and effective, inefficient and ineffective
P. Drucker (2005)	Efficiency is doing things right, and effectiveness is doing the right things. Effective actions do not have to be efficient and the other way round.
M. Sidor-Rządowska (2005)	Effective work can be inefficient, as well as efficient work does not have to be effective
<b>Efficiency = productivity/effectiveness</b>	
T. Dudycz (2007)	Efficiency in an economic sense is a relation of gained results to input used to gain the outcomes
A. Hamrol (2008)	In a technical economic view efficiency is understood as productivity
G. Osbert-Pociecha (2007)	The closest synonym of efficiency is productivity, so called, general understood as a ratio of all results of economic activity to resources used
<b>Efficiency understood as allocation of resources in a sense of Pareto</b>	

<sup>17</sup> *Słownik języka polskiego*, red. W. Doroszewski, Available online: <http://doroszewski.pwn.pl/haslo/efektywno%C5%9B%C4%87/> [accessed on: 23.05.2020].

D.R. Kamerschen, R.B. McKenzie, C. Nardinelli (1991)	Efficiency is maximisation of production resulting from a proper allocation of resources with stated limitations of supply (costs incurred by producers) and demand (consumers preferences)
E. Czarny, E. Nojszewska (2000)	Efficiency is an optimal allocation of resources production factors, products, and optimal distribution of income
P.A. Samuelson, W.D. Nordhaus (1999)	Efficiency means that there is no mismanagement. Economy functions efficiently when increase of production of one good does not decrease production of the other one

**Source:** Self-study based on G. Kozuń-Cieślak, *Efektywność – rozważania nad istotą i typologią*, „Kwartalnik Kolegium Ekonomiczno-Społecznego Studia i Prace” 2013, no 4, p. 14-15.

All presented definitions confirm that efficiency entails many aspects and strands<sup>18</sup>. Proper understanding of this definition needs to be connected with the context in which it was used. Apart from differences in a way of describing and defining efficiency majority of economists shares the same idea that efficiency is made of capability and effectiveness which interact together<sup>19</sup>. From the point of view of organizing an economic unit more important is effectiveness than capability because it is effectiveness that determines a success of an economic unit.

### 3. Non-Parametric DEA Method

DEA method was considered to be the most suitable for the efficiency analysis. Its dominance among other methods follows mainly from the fact that in multidimensional data sets, both input and outcome sets, traditional ratio methods and other econometric methods do not work out. It happens because in these two methods it is estimated that we can define how big input of a kind was directly used in order to gain particular results. In practice such calculations require specific accounting information which in many cases is impossible to submit<sup>20</sup>. DEA method was presented for the first time by A. Charnes, W. Cooper, and E. Rhodes in 1978 in the article *Measuring the efficiency of decision-making units*. In the literature it appeared at the end of 1970s, but it was mainly based on a concept of efficiency presented by M.J. Farrell twenty years earlier.

In 1978 in “European Journal of Operational Research” Abraham Charnes, William Wager Cooper and Edwardo Rhodes published the article *Measuring the*

<sup>18</sup>Warto również przywołać definicje efektywności w ujęciu prakseologicznym. Witold Kieżun na podstawie Traktatu o dobrej robocie Tadeusza Kotarbińskiego zauważył, że synonimem efektywności w sensie prakseologicznym jest sprawność, która zawiera w sobie jakby podkategorie, tj. skuteczność, korzystność czy ekonomiczność. W. Kieżun, *Podstawy organizacji i zarządzania*, Warszawa 1977, p. 44.

<sup>19</sup>See J. Supernat, *Zarządzanie*, Wrocław 2005.

<sup>20</sup>B. Guzik, *Podstawowe możliwości analityczne modelu CCR-DEA*, „Badania Operacyjne i Decyzje” 2009, no 1, p. 57.

efficiency of decision-making units<sup>21, 22</sup>. They presented a model of data envelopment based on a concept of productivity presented by Gérard Debreu<sup>23</sup> and M. J. Farrell<sup>24</sup>. They defined a measurement of efficiency as a quotient of a single result from a single input by generalising its multidimensional case in which many outcomes have many inputs.

A subject of an analysis in DEA method is a DMU, decision making unit and its aim is to measure efficiency that a given unit uses to transform inputs into outcomes (it is not necessary to define dependence between inputs and outcomes). At the same time, we can distinct two functions of an aim: one maximisation of outcomes with unmodified inputs and minimisation of inputs with the same level of outcomes. To solve such aim function, we use techniques of linear programming, on the basis of which an efficiency curve is determined (envelope). All the efficient units are located on it. In case of these units an efficiency measure ( $\theta$ ) equals 1 and for inefficient units this measure is from 0 to 1<sup>25</sup>. The difference between a level of efficiency of given DMU and 1 indicates a possibility to reduce inputs with the same outcomes. Alternatively, it shows how outcomes should increase with the same level of inputs and the unit stays efficient. In order to get authoritative results of efficiency of a research group following conditions should be fulfilled:

1. The number of units analysed should be at least three times bigger than a number of variables which constitutes a sum of a number of inputs and results as to guarantee sufficient levels of space<sup>26</sup>.
2. Increase of an input leads to increase of an outcome, it means that there is an important positive dependence between the variables.
3. Homogeneity of DMU<sup>27</sup>.

Very often, apart from aforementioned conditions, in the literature you can find additional condition to exclude extreme values from the research group<sup>28</sup>. Below you can find advantages and disadvantages of DEA method (**Σφάλμα! Το αρχείο προέλευσης της αναφοράς δεν βρέθηκε.**2).

<sup>21</sup>A. Charnes, W.W. Cooper, E. Rhodes, *Measuring the efficiency of decision-making units*, "European Journal of Operational Research" 1978, Vol. 2, Issue 6, p. 429–444.

<sup>22</sup>Wiecej: Boussofiane A., Dyson R.G., Thanassoulis E., *Applied Data Envelopment Analysis*, „European Journal of Operational Research” 1991, Vol. 52(1), Bowlin W.F., *Measuring Performance: An Introduction to Data Envelopment Analysis (DEA)*, „Journal of Cost Analysis” 1998, Vol. 15, Issue 2, p. 3–27.

<sup>23</sup>G. Debreu, *The coefficient of resource utilization*, „Econometrica” 1951, Vol. 19, No. 3.

<sup>24</sup>M.J. Farrell, *The Measurement of Productive Efficiency*, „Journal of the Royal Statistical Society. Series A” 1957, Vol. 120, No. 3.

<sup>25</sup>Zob. H.O. Fried, C.A. Knox Lovell, S. Schmidt, *The Measurement of Productive Efficiency Techniques and Applications*, New York–Oxford 1993, p. 10.

<sup>26</sup>The number of degrees of freedom relates to the number of independent random variables.

<sup>27</sup>See. W.F. Bowlin, *Measuring Performance: An Introduction to Data Envelopment Analysis (DEA)*, „Journal of Cost Analysis” 1998, Vol. 15, Issue 2, p. 3–27.

<sup>28</sup>See. K. Stępień, *Konsolidacja a efektywność banków w Polsce*, Warszawa 2004, p. 140.

**Table 2. Advantages and disadvantages of DEA method**

<b>Advantages</b>	<b>Disadvantages</b>
Does not require stating values of input and outcomes.	Calculates only relative efficiency measures for all DMUs from one trial.
It can be used in a multidimensional situation in which there is more than one input and more than one outcome.	A number of investigated units cannot be too small and too big. In case of a small group there is a possibility of false identification of inefficient units as efficient. On the other hand, too many units can lead to imbalanced homogeneity of a group.
Estimates inputs to save or to gain better outcome with given input.	High sensitivity for abnormal variables. Measurement error can influence a shape of an envelope and at the same time an efficiency outcome. Sometimes ranking of units due to their efficiency is impossible, especially when too many units are considered as efficient. Then, it is necessary to use additional super efficiency measures. For only few variables an efficiency analysis gives more chances for a complete ranking but then a process of production is not realistic. On the other hand, taking into consideration a more data makes a production process more realistic but makes it difficult to create a ranking.
It does not require to specify function dependency between inputs and outcomes.	Efficiency is measured in ratio of an analysed group of DMUs that' why adding or excluding given DMU may influence efficiency of a particular DMU.
Inputs and outcomes are put in different physical units, it is useful especially when values of inputs and outcomes are clearly defined.	
It enables to find extreme values which are not visible when other methods are used due to data averaging.	
Formulas are defined on the basis of results from economic practice. Comparison of a model unit with a combination of model units enables inefficient units to identify areas to improve. Additionally, it allows to define aims to gain and to evaluate the level of realization at a period of time.	

**Source:** Self-study based on Boussofiane A., Dyson R.G., Thanassoulis E., *Applied Data Envelopment Analysis*, „*European Journal of Operational Research*” 1991, Vol. 52(1), Bowlin W.F., *Measuring Performance: An Introduction to Data Envelopment Analysis (DEA)*, „*Journal of Cost Analysis*” 1998, Vol. 15, Issue 2, p. 3-27., Charnes A., Cooper W.W., Rhodes E., *Measuring the efficiency of decision making units*, „*European Journal of Operational Research*” 1978, Vol. 2, Issue 6, p. 429-444, Cylus J., Anderson G.F., *Multinational Comparison of Health Systems Data*, 2006 [online], *The Commonwealth Fund* 2007, Debreu G., *The coefficient of resource utilization*, „*Econometrica*” 1951, Vol. 19, No. 3, p. 273-292, Farrell M.J., *The Measurement of Productive Efficiency*, „*Journal of the Royal Statistical Society. Series A*” 1957, Vol. 120, No. 3 p. 253-290, Gattoufi S., Oral M., Reisman A., *A taxonomy for Data Envelopment Analysis*, „*Socio-Economic Planning Sciences*” 2004, No. 38(2-3), E.Szymańska, *Zastosowanie metody DEA do badania efektywności gospodarstw rolnych*, *Journal of Agribusiness and Rural Development* 2 (12), 2009, s.249-255.



From the time of presenting the first DEA model in 1978, a so called CCR-DEA model, (an abbreviation CCR comes from first letters of the authors surnames – Charnes, Cooper and Rhodes), there have been many modifications. Currently, a family of DEA models is well developed and the most important criterion that differentiates them is a kind of taken returns to scale<sup>29</sup> and model exposure. In the first case, there is another division into models with constant returns to scale CRS (*constant returns to scale*) or with variable returns to scale VRS (*variable returns to scale*). Among the models with returns to scale we can distinguish:

- DRS model (*decreasing returns to scale*),
- NDRS model (*non-decreasing returns to scale*),
- IRS model (*increasing returns to scale*),
- NIRS model (*non-increasing returns to scale*).

Returns to scale (in the literature interchangeably defined as economies of scale or benefits of scale) are connected with microeconomic theory about production function<sup>30</sup>. In this article a DEA model with constant and variable returns to scale was used without detailed definition of variability of the returns because all the data gathered was not sufficient for a correct identification.

Second criterion differentiating DEA model is an orientation of a model that can be either disorientated or orientated, however, this orientation is defined with reference to inputs or outputs. In case of input-oriented model, we get information how we should decrease inputs to keep the same level of outputs and to make a unit efficient. Output orientation shows how the outputs need to be increased with a current level of inputs to keep the unit efficient.

Primary form of DEA model (formula 1) assumes definition of DMU efficiency rate understood as a maximisation of a quotient of measured outcomes to measured inputs under condition that such rates will be less or equal 1 for each unit.

$$Max h_0 = \frac{\sum_{r=1}^s u_r y_{r0}}{\sum_{i=1}^m v_i x_{i0}} \quad 1.$$

under condition that:

$$\frac{\sum_{r=1}^s u_r y_{rj}}{\sum_{i=1}^m v_i x_{ij}} \leq 1; \quad dla \ j = 0, \quad 1, \dots, n \quad 2.$$

$$u_r, v_i \geq 0; \quad r = 1, \dots, s; \quad i = 1, \dots, m$$

where:

<sup>29</sup>See G. Rogowski, *Analiza efektywności banków na potrzeby zarządzania strategicznego bankiem. Część 1. Metodologia, „Badania Operacyjne i Decyzyjne” 1999, no 1, p. 75.*

<sup>30</sup>*More on returns to scale, compare Z. Dach, Podstawy mikroekonomii, Kraków 1999, p. 146-151; D. Begg et al., Mikroekonomia, Warszawa 2007, p. 200-202; G. Mankiw, M. Taylor, Mikroekonomia, Warszawa 2009, p. 361-362.*

$y_{rj}$  – return  $r$  gained by a unit  $j$ ,  
 $x_{ij}$  – input  $i$  used by a unit  $j$ ,  
 $u, v$  – measures from solving the abovementioned formula,  
 $j$  – unit of a research group.

With the usage of a transformation method of Charnes–Cooper such issue changes into a line function which can be solved by a linear programming<sup>31</sup>. Aim function takes the form of:

$$\max_{u,v} w_0 = \sum_{r=1}^s u_r y_{r0} \quad 3.$$

with limitations:

$$\begin{aligned} & \sum_{i=1}^m v_i x_{i0}, \\ & \sum_{r=1}^s u_r y_{rj} - \sum_{i=1}^m v_i x_{ij} \leq 0, \\ & u_r \geq \varepsilon \\ & v_i \geq \varepsilon \end{aligned} \quad 4.$$

where:

$y_{rj}$  – return  $r$  gained by a unit  $j$ ,  
 $x_{ij}$  – input  $i$  is used by a unit  $j$ ,  
 $u, v$  – values from solving the formula,  
 $j$  – unit of a research group,  
*constant*  $\varepsilon$  – indefinitely small number preventing from zero values for particular variables.

This kind of issue can be solved with the usage of linear programming (formula 3) with limitations (formula 4), that allow to get an optimal solution. In case of no limitations this task has indefinite number of solutions. While using the DEA method to estimate efficiency it is important to remember that the results refer only to relative efficiency in each group, and it is not possible to easily get its absolute value.

#### 4. Measuring Efficiency of Medical Units

Before getting to an operationalization of a research problem there had been many assumptions made:<sup>32</sup>

<sup>31</sup>See. G. Rogowski, *Metody analizy i oceny działalności banku na potrzeby zarządzania strategicznego*, Poznań 1999, p. 134.

<sup>32</sup>See. Rebba V., Rizzi D., *Measuring hospital efficiency through Data Envelopment Analysis when policymakers' preferences matter*, „Working Papers, Department of Economics” 2006, No. 13.

- the first one was a choice of a research group, where we qualified only general hospitals, more precisely hospital departments. Research area was limited only to the Lower Silesia Province because analysed units should be functioning in a similar environment (external<sup>33</sup>, in particular in a homogenous legal and administrative surrounding.)
- the choice of only functioning units in a given province allows to meet the condition, its common element is cooperation with regional branch of NHF and State Sanitary Inspectorate. A consequence of taking such assumptions is limiting an analysis only to two legal-organisational forms such as SPZOZ and limited company and reducing the number of units that a research group was chosen from.

Provincial Lower Silesian branch of NHF (hereafter: DOW NFZ) in 2018 had at its disposal around 6,093,684,000.00 PLN (six billion ninety three million six hundred eighty four thousand PLN) for buying health benefits within general insurance and from this sum around 3,167,886,000.00 PLN (three billion one hundred and sixty seven million and eight hundred eighty six thousand PLN), that is almost 52% of annual budget that was allocated to finance hospital treatment in Lower Silesia Province<sup>34</sup>. In order to do this, in 2018 DOW NFZ signed 172 agreements with 76 providers in a scope of stationary health service. Within a chosen research group there were excluded those that are small, most often with one profile of activity and they did not perform constantly<sup>35</sup>. Finally, there were 48 providers qualified for the research of technical efficiency. The aggregated value of agreements with DOW NFZ in terms of hospital treatment in 2018 reached 3,155,000,000.00 PLN (three billion one hundred fifty-five million PLN) and that constituted 99% of the budget for financing hospital treatment in the whole Lower Silesia Province.

A specialized research group of health service units is composed of particular hospital departments that are managed within their structures. The research involved two departments that are contractual products – general surgery and internal medicine. A selection followed from a level of generalness. A general surgery and internal medicine are counted as basic departments, that is why they can be found in almost every county of Lower Silesia Province. 39 of internal medicine departments and 35 of general surgery departments were taken into consideration in the analysis. For the need of the research two authorial research models were created a basic model and an extended one.

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<sup>33</sup>*It is possible to distinguish a general environment (macro environment), deliberate (microenvironment) and regional (meso environment). Among the most important external factors which condition functioning of medical unit we can point out a cooperation between provincial units of NHF that are responsible for benefits contracts in a given area. In each region a management of provincial NHF has its own, differentiated policy eg. in terms of payment for extra benefits.*

<sup>34</sup>*Plan finansowy NFZ na 2018 r., available online: <http://nfz.gov.pl/bip/finanse-nfz/> [access: 6.06.2020].*

<sup>35</sup>*Due to high rating of benefits with reference to actual costs, eg. from ophthalmology area (cataract treatment) there were private planned units brought into existence. In case of such units it is not necessary to constantly provide benefits, which transfers into lower costs of this kind of activity. That is why comparing efficiency of units working all the time with planned units is impossible.*

A basic model is composed of two variables on an input side (the number of doctors in total, the number of nurses) and one variable on an outcome side (the number of patients). This is a model focused on outcomes with variable returns to scale. A change of a number of workers does not make a proportional change of gained outcomes and available data does not allow for a clear-cut distinction of a way of changes – thus variable returns to scale assumption.

An extended model is a modification of a basic model and is made of the same variables on an input side (the number of doctors in total, the number of nurses and one variable on an outcome side (the number of patients measured on the basis of JGP points<sup>36</sup>). These models are consolidated on an input side by one of the most important – in authors’ judgement – inputs that are used in health care service, medical staff. Lack of professionals in Polish system of health care, in particular in a context of ominously low number of specialists without who particular hospital department could not function properly, can lead to a structural inefficiency of a system. That is why, it is so important to use appropriately, efficiently and in an optimal way available resource. Parameters of the model are outcomes oriented and with variable returns to scale. Calculations were made with the usage of a modern programming DEAP<sup>37</sup>.

### 5. Analysis Results

Average value of a rate in the efficiency analysis of general surgery department with the usage of a basic model was from 0,700 (the lowest value in 2015) up to 0,770 (the highest value in 2014). In this time a minimal value was on the similar level comparing year 2014 and 2018. The model identified, in the first year of a study, 9 units that were fully efficient, 5 of which were independent public units of health care service and 4 of them limited companies. In case of five periods of time, it was a limited company that was the least efficient. A decrease of efficiency, in a set of units that are not of a business type, is also visible in case of an average value for this group – it also decreased similarly as average efficiency of limited companies.

**Table 3. Results of personal model – general surgery**

DMU	Model DEA VRS outcomes oriented, Inputs: number of doctors, number of nurses, Outcomes: number of patients									
	2014		2015		2016		2017		2018	
	result	ranking	result	ranking	result	ranking	result	ranking	result	ranking
DMU_10	0,375	33	0,409	31	0,421	30	1,000	1	0,877	8
DMU_12	0,704	24	0,521	25	0,600	19	0,653	18	0,509	29
DMU_13	0,693	26	0,364	32	0,388	31	0,392	31	0,365	30
DMU_16	0,706	23	0,592	20	0,532	23	0,566	25	0,526	27
DMU_17	1,000	1	1,000	1	1,000	1	1,000	1	1,000	1
DMU_18	0,913	12	0,732	15	No dat	No data	No dat	No data	No data	No data

<sup>36</sup>Homogenous group of patients

<sup>37</sup>The programme that was used is DEAP Version 2.1 (A Data Envelopment Analysis Program). It was created by Tim Coelli from Centre for Efficiency and Productivity Analysis, School of Economics, University of Queensland. Available online: <http://www.uq.edu.au/economics/cepa/> [access: 06.06.2020].

DMU_2	0,988	10	0,971	8	0,531	24	0,750	15	0,647	20
DMU_20	0,689	27	0,576	21	0,522	25	0,554	26	0,544	24
DMU_21	0,848	16	0,767	12	0,716	15	0,698	16	0,732	15
DMU_22	0,835	17	0,897	9	0,657	17	0,650	19	0,655	19
DMU_24	0,856	15	0,713	16	0,762	14	0,771	13	0,881	7
DMU_26	1,000	1	0,750	14	0,574	21	0,583	23	0,659	18
DMU_27	1,000	1	0,482	29	0,501	28	0,633	21	0,581	23
DMU_28	0,711	22	0,624	18	0,819	12	0,928	8	0,827	11
DMU_29	0,514	30	0,510	27	0,522	25	0,519	27	0,519	28
DMU_3	0,588	28	0,551	23	0,626	18	0,489	30	0,544	24
DMU_31	0,774	20	0,571	22	0,804	13	0,851	11	0,791	13
DMU_32	1,000	1	1,000	1	1,000	1	1,000	1	1,000	1
DMU_33	1,000	1	1,000	1	0,936	8	0,627	22	1,000	1
DMU_34	1,000	1	0,867	10	0,829	11	0,849	12	0,771	14
DMU_35	0,726	21	0,532	24	0,553	22	0,669	17	0,622	21
DMU_38	0,821	18	0,761	13	0,881	10	0,914	10	0,813	12
DMU_39	0,423	31	0,494	28	0,517	27	0,497	29	0,598	22
DMU_4	0,530	29	No data	No data	No dat	No data	No dat	No data	No data	No data
DMU_40	1,000	1	1,000	1	1,000	1	1,000	1	0,858	10
DMU_41	0,900	13	0,828	11	1,000	1	0,947	7	1,000	1
DMU_42	0,700	25	0,513	26	0,593	20	0,648	20	0,667	17
DMU_44	0,885	14	0,696	17	0,884	9	0,920	9	0,876	9
DMU_45	1,000	1	1,000	1	1,000	1	1,000	1	1,000	1
DMU_46	0,810	19	0,615	19	0,687	16	0,769	14	0,705	16
DMU_47	0,388	32	0,455	30	0,490	29	0,513	28	No data	No data
DMU_48	0,921	11	1,000	1	1,000	1	1,000	1	1,000	1
DMU_5	0,272	35	No data	No data	No dat	No data	No dat	No data	No data	No data
DMU_6	1,000	1	1,000	1	1,000	1	0,570	24	0,533	26
DMU_9	0,374	34	0,311	33	0,296	32	0,310	32	0,262	31
<b>Average</b>	<b>0,770</b>		<b>0,700</b>		<b>0,708</b>		<b>0,727</b>		<b>0,721</b>	
<b>Minimum</b>	<b>0,272</b>		<b>0,311</b>		<b>0,296</b>		<b>0,310</b>		<b>0,262</b>	
<b>SPZOZ</b>	<b>0,388</b>		<b>0,455</b>		<b>0,490</b>		<b>0,497</b>		<b>0,519</b>	
<b>Private limited company</b>	<b>0,272</b>		<b>0,311</b>		<b>0,296</b>		<b>0,310</b>		<b>0,262</b>	
<b>Average inefficiency</b>	<b>0,690</b>		<b>0,619</b>		<b>0,626</b>		<b>0,664</b>		<b>0,654</b>	
<b>Average efficiency of SPZOZ</b>	<b>0,826</b>		<b>0,727</b>		<b>0,734</b>		<b>0,768</b>		<b>0,774</b>	
<b>Average efficiency of private limited company</b>	<b>0,703</b>		<b>0,663</b>		<b>0,674</b>		<b>0,674</b>		<b>0,657</b>	
<b>Efficient DMU</b>	<b>9</b>		<b>7</b>		<b>7</b>		<b>6</b>		<b>6</b>	
<b>SPZOZ</b>	<b>5</b>		<b>4</b>		<b>5</b>		<b>4</b>		<b>4</b>	
<b>Private limited company</b>	<b>4</b>		<b>3</b>		<b>2</b>		<b>2</b>		<b>2</b>	

Source: Self-study based on data from DOW NFZ.

Second model used in an efficiency analysis of general surgery department functioning has the same variables on the input side as a basic model, however, on the outcome side the number of patients is measured on the basis of JGP points. Results of the study, in which this extended model was used, are presented in Table 4. In case

of all analysed units' average efficiency in 2014-2018 went down from z 0,730 to 0,663. Bigger differences are visible after gradation because of organizational-legal form. Average value of efficiency rate for SPZOZ in 2014 was 0,802 and was higher than in a limited company case (0,645). In the last year of an analysis we can see significant dominance of fully efficient units. Among units that were not of a business type we could distinguish four units fully efficient and only one being a limited company.

**Table 4. Results of an extended model – general surgery**

DMU	Model DEA VRS outcomes oriented. Inputs: numbers of doctors, number of nurses, Outcomes: number of patients measured by JGP points									
	2014		2015		2016		2017		2018	
	result	ranking	result	ranking	result	ranking	result	ranking	result	ranking
DMU_10	0,359	33	0,045	30	0,542	20	1,000	1	0,761	12
DMU_12	0,622	22	0,050	28	0,421	27	0,577	21	0,459	25
DMU_13	0,558	28	0,036	31	0,379	31	0,347	30	0,357	30
DMU_16	0,614	23	0,077	18	0,463	25	0,550	23	0,476	24
DMU_17	0,779	16	0,083	16	0,817	10	0,928	8	0,804	8
DMU_18	0,572	25	0,051	26	No dat	No data	No dat	No data	No dat	No data
DMU_2	0,902	12	1,000	1	0,448	26	0,647	16	0,581	19
DMU_20	0,630	21	0,053	25	0,416	28	0,409	28	0,401	28
DMU_21	0,607	24	0,059	23	0,607	16	0,501	27	0,530	21
DMU_22	0,737	19	0,190	5	0,645	14	0,608	20	0,664	16
DMU_24	0,565	26	1,000	1	0,466	24	0,610	19	0,589	18
DMU_26	0,941	11	0,126	10	0,602	17	0,774	11	0,763	11
DMU_27	1,000	1	0,047	29	0,393	30	0,508	25	0,498	23
DMU_28	0,729	20	0,059	23	0,717	12	0,862	9	0,729	13
DMU_29	0,479	30	0,051	26	0,495	23	0,393	29	0,410	27
DMU_3	0,411	31	0,035	32	0,398	29	0,201	32	0,401	28
DMU_31	0,951	10	0,065	20	0,691	13	0,634	18	0,662	17
DMU_32	1,000	1	0,189	6	1,000	1	1,000	1	1,000	1
DMU_33	1,000	1	1,000	1	1,000	1	1,000	1	1,000	1
DMU_34	1,000	1	0,091	14	0,768	11	0,722	14	0,775	10
DMU_35	0,847	14	0,061	21	0,498	22	0,645	17	0,571	20
DMU_38	0,809	15	0,089	15	0,862	8	0,721	15	0,716	15
DMU_39	0,554	29	0,060	22	0,538	21	0,522	24	0,528	22
DMU_4	0,305	34	No dat	No data	No dat	No data	No dat	No data	No dat	No data
DMU_40	0,888	13	0,144	9	0,992	6	0,846	10	0,816	7
DMU_41	0,760	17	0,101	11	0,825	9	0,740	12	0,727	14
DMU_42	0,742	18	0,068	19	0,634	15	0,735	13	0,776	9
DMU_44	1,000	1	0,098	13	1,000	1	1,000	1	1,000	1
DMU_45	1,000	1	0,157	8	1,000	1	1,000	1	1,000	1
DMU_46	1,000	1	0,099	12	0,949	7	0,968	7	0,860	6
DMU_47	0,564	27	0,080	17	0,549	19	0,503	26	No dat	No data
DMU_48	1,000	1	0,159	7	1,000	1	1,000	1	1,000	1
DMU_5	0,229	35	No dat	No data	No dat	No data	No dat	No data	No dat	No data
DMU_6	1,000	1	1,000	1	0,561	18	0,563	22	0,457	26
DMU_9	0,392	32	0,029	33	0,298	32	0,286	31	0,234	31
<b>Average</b>	<b>0,730</b>		<b>0,196</b>		<b>0,655</b>		<b>0,681</b>		<b>0,663</b>	
<b>Minimum</b>	<b>0,229</b>		<b>0,029</b>		<b>0,298</b>		<b>0,201</b>		<b>0,234</b>	
<b>SPZOZ</b>	<b>0,479</b>		<b>0,047</b>		<b>0,393</b>		<b>0,393</b>		<b>0,410</b>	
<b>Private limited company</b>	<b>0,229</b>		<b>0,029</b>		<b>0,298</b>		<b>0,201</b>		<b>0,234</b>	
<b>Average inefficiency</b>	<b>0,636</b>		<b>0,085</b>		<b>0,592</b>		<b>0,608</b>		<b>0,598</b>	

Average efficiency of SPZOOZ	0,802	0,192	0,714	0,729	0,727
Average efficiency of private limited company	0,645	0,201	0,580	0,621	0,584
Efficient DMU	9	4	5	6	5
SPZOOZ	6	2	4	4	4
Private limited company	3	2	1	2	1

*Source: Self-study based on data from DOW NFZ.*

In a summary of a study on efficiency of general surgery departments functioning within two different organizational and legal forms it should be highlighted that results of particular models show dominance of units functioning in a frame of SPZOOZ as those more efficient.

Second representative of a set of basic units that was considered in the analysis is a department of general medicine. We found out in the research that it was the most numerously represented. At the end of 2018 it was present in 35 health care units, 16 of which were in a form of limited company and 19 in a form of SPZOOZ. General medicine plays a major role in a health care system. On one side it is a diagnostic department where they proceed with tests and in case of a correct diagnosis a patient can be directed to a specialist department or a decision is made to keep him at the department to continue with a treatment. On the other side, a general medicine is used as a unit where patients undergo recuperation after specialist procedures.

Results of efficiency analysis at general medicine departments with the usage of a personal model were presented in Table 5. They show stabilization of efficiency level in the researched period. The average slightly lowered from 0,719 in 2014 to 0,709 in 2018. At the same time there was a drastic decrease of the lowest value, in 2014 it was 0,365 and in 2018 0,056. Results that take into consideration a division into an organizational and legal form show disproportion and at the same time superiority of limited companies over SPZOOZ.

In 2014 average efficiency for the first group was close to an average value of an efficiency rate for an independent public health care units – the difference, in favour of limited companies, in a level of efficiency which increased from 0,019 to 0,091 when comparing year 2014 and 2018. During the research time among the number of fully efficient units we could mark additional one and in a second group the number of fully efficient units equaled four both at the beginning and at the end of the analysis.

**Table 5. Results of a basic model – general medicine**

DMU	Model DEA VRS outcomes oriented, Inputs: number of doctors, number of nurses, Outcomes: number of patients									
	2014		2015		2016		2017		2018	
	result	ranking	result	ranking	result	ranking	result	ranking	result	ranking
DMU_1	0,716	18	0,546	30	0,535	30	0,560	26	0,575	25
DMU_10	1,000	1	1,000	1	1,000	1	1,000	1	0,859	13
DMU_12	0,632	24	0,644	22	0,773	19	0,720	17	1,000	1
DMU_13	1,000	1	1,000	1	1,000	1	0,828	15	0,529	27
DMU_16	0,647	23	0,596	26	0,572	27	0,766	16	0,681	20
DMU_17	1,000	1	1,000	1	1,000	1	0,859	11	1,000	1
DMU_18	0,707	21	0,800	13	No dat	No data	No dat	No data	No data	No data
DMU_2	1,000	1	1,000	1	1,000	1	0,593	24	0,579	24
DMU_20	0,755	16	0,657	19	0,595	25	0,684	20	0,666	22
DMU_21	0,879	11	0,965	10	0,796	17	0,640	22	0,696	18
DMU_22	0,532	32	0,551	29	0,575	26	0,638	23	0,532	26
DMU_24	0,782	15	0,640	23	0,905	14	0,833	14	0,710	17
DMU_26	0,703	22	0,679	18	0,633	24	0,693	19	0,757	16
DMU_27	0,839	13	0,777	14	0,792	18	0,719	18	0,886	12
DMU_28	1,000	1	1,000	1	1,000	1	1,000	1	1,000	1
DMU_29	0,407	37	0,432	35	0,708	21	0,448	31	0,603	23
DMU_3	0,472	34	0,487	32	0,550	29	0,550	27	0,380	32
DMU_30	0,601	25	0,634	24	0,430	33	0,384	34	0,350	33
DMU_31	0,790	14	0,764	15	1,000	1	1,000	1	0,766	15
DMU_32	0,927	10	0,914	11	0,935	13	0,838	13	0,776	14
DMU_33	0,733	17	0,582	27	0,748	20	0,582	25	0,678	21
DMU_34	1,000	1	1,000	1	1,000	1	1,000	1	1,000	1
DMU_35	0,709	20	0,652	21	0,702	22	0,840	12	1,000	1
DMU_36	0,366	38	0,363	37	0,312	36	0,352	36	0,339	34
DMU_37	0,570	30	0,579	28	0,561	28	0,461	30	0,460	29
DMU_38	0,601	25	0,716	16	0,875	16	0,679	21	1,000	1
DMU_39	1,000	1	1,000	1	1,000	1	1,000	1	1,000	1
DMU_4	0,524	33	No dat	No data	No dat	No data	No dat	No data	No data	No data
DMU_40	0,465	35	0,488	31	0,498	32	0,518	29	0,474	28
DMU_41	0,365	39	0,381	36	0,341	35	0,365	35	0,395	30
DMU_42	0,843	12	0,914	11	0,946	12	0,988	10	0,985	11
DMU_44	1,000	1	1,000	1	1,000	1	1,000	1	1,000	1
DMU_45	1,000	1	1,000	1	1,000	1	1,000	1	0,056	35
DMU_46	0,581	29	0,657	19	0,671	23	0,399	33	0,389	31
DMU_47	0,600	27	0,457	34	0,400	34	0,423	32	Lack of data	Lack of data
DMU_48	0,543	31	0,476	33	0,504	31	0,548	28	0,684	19
DMU_5	0,450	36	No dat	No data	No dat	No data	No dat	No data	No data	No data
DMU_6	0,599	28	0,603	25	1,000	1	1,000	1	1,000	1
DMU_9	0,710	19	0,688	17	0,894	15	1,000	1	1,000	1
<b>Average</b>	<b>0,719</b>		<b>0,720</b>		<b>0,757</b>		<b>0,720</b>		<b>0,709</b>	
<b>Minimum</b>	<b>0,365</b>		<b>0,363</b>		<b>0,312</b>		<b>0,352</b>		<b>0,056</b>	
<b>SPZOZ</b>	<b>0,365</b>		<b>0,363</b>		<b>0,312</b>		<b>0,352</b>		<b>0,056</b>	
<b>Private limited company</b>	<b>0,450</b>		<b>0,487</b>		<b>0,535</b>		<b>0,461</b>		<b>0,380</b>	
<b>Average inefficiency</b>	<b>0,635</b>		<b>0,630</b>		<b>0,650</b>		<b>0,626</b>		<b>0,592</b>	
<b>Average efficiency of SPZOZ</b>	<b>0,710</b>		<b>0,712</b>		<b>0,722</b>		<b>0,663</b>		<b>0,667</b>	
<b>Average efficiency of</b>	<b>0,729</b>		<b>0,731</b>		<b>0,800</b>		<b>0,791</b>		<b>0,758</b>	



private limited company									
Efficient DMU	9		9		11		9		10
SPZOZ	4		4		4		3		4
Private limited company	5		5		7		6		6

Source: Self-study based on data from DOW NFZ.

Results of the study with the usage of an extended model for a general medicine department were presented in Table 6 – they show even bigger disproportion in an efficiency level between limited companies and independent public health care units, in favour of the first group. A difference in an average efficiency of these two groups increased from 0,019 to 0,143 (comparing 2014 and 2018). The group of limited companies is the most numerous in a group of fully efficient units (4 out of 7 were efficient in 2014 and 5 out of 6 were efficient in 2018).

Table 6. Results of an extended model – general medicine department

DMU	Model DEA VRS outcomes oriented, Inputs: numbers of doctors, number of nurses, Outcomes: number of patients measured by JGP points									
	2014		2015		2016		2017		2018	
	result	ranking	result	ranking	result	ranking	result	ranking	result	ranking
DMU_1	0,546	32	0,454	34	0,437	34	0,356	34	0,362	33
DMU_10	1,000	1	1,000	1	1,000	1	1,000	1	0,919	8
DMU_12	0,610	25	0,591	24	0,732	22	0,573	21	0,868	9
DMU_13	1,000	1	1,000	1	0,997	10	0,743	13	0,538	26
DMU_16	0,621	24	0,577	27	0,585	28	0,716	16	0,694	15
DMU_17	1,000	1	1,000	1	1,000	1	0,804	11	1,000	1
DMU_18	0,629	23	0,680	17	No dat	No data	No data	No data	No dat	No data
DMU_2	1,000	1	1,000	1	1,000	1	0,551	22	0,545	25
DMU_20	0,787	15	0,672	19	0,611	25	0,588	19	0,632	20
DMU_21	0,687	18	0,776	14	0,900	13	0,804	11	0,772	13
DMU_22	0,510	36	0,676	18	0,757	20	0,691	18	0,635	19
DMU_24	0,849	13	0,262	37	0,811	18	0,721	15	0,673	16
DMU_26	0,592	26	0,548	29	0,531	29	0,551	22	0,576	24
DMU_27	0,670	19	0,590	25	0,632	24	0,550	24	0,590	22
DMU_28	0,989	8	0,872	8	1,000	1	1,000	1	1,000	1
DMU_29	0,571	29	0,619	20	0,887	14	0,536	26	0,642	18
DMU_3	0,544	33	0,498	32	0,489	30	0,385	32	0,439	28
DMU_30	0,505	37	0,569	28	0,486	31	0,332	36	0,287	34
DMU_31	0,923	9	0,852	11	1,000	1	1,000	1	0,820	12
DMU_32	0,867	12	0,816	12	0,857	15	0,724	14	0,646	17
DMU_33	0,669	20	0,515	31	0,590	27	0,444	28	0,578	23
DMU_34	1,000	1	1,000	1	1,000	1	1,000	1	1,000	1
DMU_35	0,880	11	0,714	16	0,835	17	0,702	17	0,858	10
DMU_36	0,383	39	0,381	36	0,343	36	0,384	33	0,364	32
DMU_37	0,539	34	0,603	23	0,472	32	0,354	35	0,394	29
DMU_38	0,573	28	0,613	22	0,746	21	0,461	27	0,741	14
DMU_39	1,000	1	1,000	1	1,000	1	1,000	1	1,000	1
DMU_4	0,516	35	No dat	No data	No dat	No data	No data	No data	No dat	No data
DMU_40	0,551	31	0,582	26	0,638	23	0,576	20	0,531	27
DMU_41	0,437	38	0,401	35	0,414	35	0,403	30	0,382	30
DMU_42	0,806	14	0,853	10	0,854	16	0,922	9	0,930	7

DMU_44	0,908	10	0,865	9	0,931	11	0,869	10	0,839	11
DMU_45	1,000	1	1,000	1	1,000	1	1,000	1	0,040	35
DMU_46	0,743	17	0,812	13	0,786	19	0,391	31	0,367	31
DMU_47	0,662	21	0,522	30	0,460	33	0,432	29	No dat	No data
DMU_48	0,650	22	0,494	33	0,602	26	0,542	25	0,599	21
DMU_5	0,556	30	No dat	No data	No dat	No data	No data	No data	No dat	No data
DMU_6	0,583	27	0,614	21	1,000	1	1,000	1	1,000	1
DMU_9	0,784	16	0,746	15	0,926	12	1,000	1	1,000	1
<b>Average</b>	<b>0,722</b>		<b>0,696</b>		<b>0,759</b>		<b>0,670</b>		<b>0,665</b>	
<b>Minimum</b>	<b>0,383</b>		<b>0,262</b>		<b>0,343</b>		<b>0,332</b>		<b>0,040</b>	
<b>SPZOZ</b>	<b>0,383</b>		<b>0,262</b>		<b>0,343</b>		<b>0,332</b>		<b>0,040</b>	
<b>Private limited company</b>	<b>0,510</b>		<b>0,454</b>		<b>0,437</b>		<b>0,354</b>		<b>0,362</b>	
<b>Average inefficiency</b>	<b>0,661</b>		<b>0,626</b>		<b>0,678</b>		<b>0,575</b>		<b>0,595</b>	
<b>Average efficiency of SPZOZ</b>	<b>0,713</b>		<b>0,671</b>		<b>0,736</b>		<b>0,623</b>		<b>0,599</b>	
<b>Average efficiency of private limited company</b>	<b>0,732</b>		<b>0,729</b>		<b>0,787</b>		<b>0,728</b>		<b>0,742</b>	
<b>Efficient DMU</b>	<b>7</b>		<b>7</b>		<b>9</b>		<b>8</b>		<b>6</b>	
<b>SPZOZ</b>	<b>3</b>		<b>3</b>		<b>3</b>		<b>2</b>		<b>1</b>	
<b>Private limited company</b>	<b>4</b>		<b>4</b>		<b>6</b>		<b>6</b>		<b>5</b>	

Source: Self-study based on data from DOW NFZ.

On the basis of research results efficiency of general surgery departments such statement is justified that it cannot be unambiguously pointed out which organizational-legal form (SPZOZ or limited companies) is more efficient. However, the results confirm that public units are not less efficient than commercial ones.

## 6. Conclusion

Hospitals are the most important units functioning within a health care system in Poland. Research and analyses of their financial situation also the way of using the resources are vital – from the point of view of many groups of stakeholders – and should be performed by a Ministry of Health and National Health Fund. Improvement of efficiency and organisation of health care system in a context of changing demographic and epidemiologic situation, supporting scientific research, development of technology in a health care system are also major aims of European Union health care policy. Such aim was set in Poland with granted structural funds in 2014-2020. One of the possible scenarios to improve efficiency of the whole health care system in Poland is to improve efficiency of particular units with granted stable legal environment and similar financial perspectives.

Presented results of efficiency analysis of health benefits from medical units of a hospital profile in a Lower Silesia Province do not confirm statements included (and very often repeated by other stakeholders of a system) in the explanation to the Act of 15 April 2011 on medical activity stating as SPZOZ was an inefficient legal form. There is no authorisation for such constataion that limited companies are more efficient and they should constitute major group of providers. Results show that in many cases it was SPZOZ – considered as inefficient legal form – appeared to be more efficient.

Nevertheless, the results show that regardless organizational and legal form improvement of functioning efficiency of medical units is possible. That is why decision-makers of a health care system should aim at eliminating mismanagement on every level of activities through analysis of inputs in a context of generated outcomes/results. This article is a part of a discourse on the efficiency evaluation of units in a health care system. The authors believe that it will constitute to creating new models of efficiency measurement of benefits providers in a system that will be used by the institutions responsible for allocating public funds for health benefits.

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