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MACIEJ JEWCZAK[*], JADWIGA SUCHECKA[**]

Application Of Input-Output Analysis In The Health Care

Abstract

Usage of the economic analysis in the study of the performance of health care system does not surprise anyone nowadays. Trends that are drawn over the years fluctuate from the technology assessment of health programs – in terms of efficiency, costs or utility for patients, through methods to establishing co-payment for health services and the demand for medical services. Much of the interest is devoted to analysis of the shape of the health care system: the amount of contributions to the National Health Fund, the managing the system, both at the micro and macro level, or restructuring. Any method that allows to show dependencies, identify weaknesses/strengths of the health care system is appreciated by health policy makers.

The aim of this article is an attempt of the use of models of input-output type in the analysis of the performance of the health care sector in Poland. The construction of input-output model is based on the observed data for the specified, variously defined area – it may concern: country, region, municipality, etc., hence with the appropriate designed database, it may be possible to examine the flow of health benefits – for example, expressed in zlotys. Part of the article is dedicated to theoretical aspects of the input-output models and the problems this usage can cause.

***Keywords**: input-output models, the health sector, the analysis of flows*

[*] University of Lodz, Faculty of Economics and Sociology, Department of Spatial Econometrics

[**] Ph.D., Full Professor at the University of Lodz, Faculty of Economics and Sociology, Department of Spatial Econometrics

1. Introduction

One of the methods most frequently used in the world in macroeconomic studies is the analysis of input-output. With the development of computerisation the range of its applications greatly expended. IO analysis, nowadays, is used in interregional research, in analyses of environmental protection, energy consumption and in, widely understood, analysis of labor intensity. Implementation of IO analysis is also caused by the ever-expanding scale of the relationship between economic regions.

Due to the multiplicity of linkages and interdependencies of business processes it is sometimes hard to clearly identify all the purposes for gathering data for IO analysis. Major objective, while collecting information, was a comparability of data. Exploration of the national economies caused creating an unified system. In the former socialist countries material balances system (System of Material Product Balances) was widely used, while other countries carried on the social accounting system (System of National Accounts or Accounting – SNA). Functioning in two different classifications prevented any comparability (See: Tomaszewicz, 1994).

The collapse of the socialist economy of Central and Eastern Europe countries and a return to a market economy resulted in changes of the objectives and needs of the data collection – these changes aimed towards the methodology of SNA.

2. Methods

2.1. Input-output tables – national level, intra relations and basic interpretations

For the founder of input-output analysis Wassily Leontief is considered (Miller, Blair, 2009, p. 2). His first application of the empirical model was based on a linear relationship between expenditures on the production of the goods and the level of production of the goods, and referred to the year 1936.

The input-output table is created with data related to specific economic areas, which may be the national economy, but also an economic region. The figures are related to a specific period in time – in practice, it is usually a year. Input output table, in general, consists of three main parts (or quarters) – see table 1. In the first quarter, the data presents the consumption of particular products (or the production of individual branches) in the production process, i.e. the cost of the raw materials, services. In terms of IO analysis, this consumption can be called the intermediate demand (production). The second quarter in IO terminology, indicates the final demand on products (or production) and non-market services. The third part of IO table characterises the value added (the Gross Domestic Product).

Table 1.Input-output table – basic symbolism

	Products, indirect demand	Sum of intermediate demand	Final demand	Sum of final demand	Total demand
	$1 \quad 2 \quad \dots \quad j \quad \dots \quad n$		$1 \quad 2 \quad \dots \quad k \quad \dots \quad m$		
1	$\mathbf{Z} = (Z_{ij})$ $i,\ j = 1, ..., n$	Z_1	$\mathbf{Y} = (Y_{ik})$ $i = 1, ..., n$ $k = 1, ..., m$	Y_1	X_1
2		Z_2		Y_2	X_2
⋮		⋮		⋮	⋮
i		Z_i		Y_i	X_i
⋮		⋮		⋮	⋮
n		Z_n		Y_n	X_n
Σ	$K_1 \quad K_2 \quad \dots \quad K_j \quad \dots \quad K_n$				
1	$\varsigma = (\upsilon_{lj})$ $i = 1, ..., n$ $l = 1, .., s$	υ_1			
2		υ_2			
⋮		⋮			
l		υ_l			
⋮		⋮			
s		υ_s			
	$V_1 \quad V_2 \quad \dots \quad V_j \quad \dots \quad V_n$				
	$X_1 \quad X_2 \quad \dots \quad X_j \quad \dots \quad X_n$				

Legend: z_{ij} – flow from i to j sector of a homogenous product, **Z** – matrix of flows in n sectors, and m kinds of final demand, and s elements of value added; X_i – final demand of i sector; Y_i – final demand for production od i sector and **Y** – vector of expenditures of final receivers of each branch; υ_{lj} – elements of value added (for l=1, …, s), ς – matrix of value added; **V** – value added vector of each sector. Rows indicate the total output of each product is used for consumption by the various industries, and final demand purposes. Columns provide information on the input composition of the total supply of each product – this is comprised by the national production.

Source: Miller, Blair, 2009, pp. 3, 13, 47; Tomaszewicz, 1994, p. 56.

Problems of construction of the IO occur within classification, definitions, units of measurement and data arrangement. The formal properties of the data array results from the adopted system of national accounts. However, specific IO tables ultimately depend on the purposes of their construction, and typically, they are limited with the possibilities of obtaining the necessary data.

The fundamental data necessary for the IO analysis is located in the first quarter of the input-output matrix. If transactions take place between sectors of productive activity, the matrix is called the matrix of interindustry flows. In this section, manufacturing sectors (branches, groups of branches) are also presented as activities wearing products (manufactures) of other sectors.

In general, the data flow between distinguished products manufacturing sectors may be presented in physical units – this causes measurement problems, which in general are greater, then when the flows are expressed in monetary terms. However, the monetary units are also not universal, as the prices of goods are changing and make it difficult to analyse the level of inputs in physical units and can distort the image of significant changes in technology and the structure of outputs.

The second quarter of the IO does not concern production – it indicates the final demand. Generally, the final demand includes private consumption (the households), consumption expenditure (the government), net export (the foreign customers), capital expenditures (the investors) and demand for the product associated with the change in inventory levels. The basic theory of IO assumes that the final demand is exogenous in relation to the manufacturing sectors, i.e. does not depend on the level of production in these sectors. The final demand equals the sum of demands (expenditures) of all final receivers (k=1, … , m) for i sector's production $Y_i = \sum_{k=1}^{m} y_{ik}$.

For each of n sectors it is possible to construct equations for production used on productive purposes (Miller, Blair, 2009, p. 19):

$$\begin{aligned} X_1 &= z_{11} + z_{12} + \ldots + z_{1n} + Y_1, \\ X_2 &= z_{21} + z_{22} + \ldots + z_{2n} + Y_2, \\ &\vdots \\ X_n &= z_{n1} + z_{n2} + \ldots + z_{nn} + Y_n. \end{aligned} \tag{1}$$

In the similar sense, it is possible to construct equations expressing the inputs in each j sector:

$$\begin{aligned} X_1 &= z_{11} + z_{12} + \ldots + z_{1n} + V_1, \\ X_2 &= z_{21} + z_{22} + \ldots + z_{2n} + V_2, \\ &\vdots \\ X_n &= z_{n1} + z_{n2} + \ldots + z_{nn} + V_n. \end{aligned} \tag{2}$$

The first equation system indicates the total consumption of the production of each sector, i.e. the total demand of production and final recipients for the production of each sector, and the second system – the inputs on the production of these sectors, i.e. the value of global production of each sector. Because the value of the total consumption of the outputs of the sector must be equal to the value of outputs produced (assuming that there is no import), the X_i=X_j when i=j.

The fundamental assumption in IO analysis is that the flow of products from *i* to *j* sector depends on the level of global production of *j* sector. Significantly, the higher level of car production, the higher demand of different products: steel, coal, leather or textiles. On the basis of IO analysis it is possible to compare the inputs and global value to calculate the technical or direct input ratios: $a_{ij} = z_{ij} / X_j$. Further it is possible to establish the matrix of the IO ratios: $\mathbf{A}_{nxn} = [a_{ij}]$, and using this coefficients, it is possible to express the total production of each sector:

$$\mathbf{X} = \mathbf{AX} + \mathbf{Y}\,. \tag{3}$$

2.2. Regional and multiregional IO models

In literature, there are at least two main factors that distinguish the modelling issues at regional level from IO models for the entire national economy. Firstly, the structure of expenditures on production in the region could be significantly different from the structure described by the matrix **A** coefficients for the whole country. Secondly, if the considered region is smaller, the more economically dependent from its surrounding it becomes.

There are many reasons for IO analysis at the regional level (Miller, Blair, 2009, pp. 70-75). These models should primarily provide assistance in determining the impact of the additional final demand both for products manufactured in the region, as well as for traded into the region raw materials and other products.

The main problem arising in connection with the analysis of input-output at the regional level is the construction of an array of coefficients of direct regional expenditures. Such estimates are rarely constructed on the basis of surveys, and most often generated on the basis of technical coefficients for the whole country. Although, this solution is more frequently used, it is problematic to transform direct input ratios of the structure on national level to the regional scheme, due to, for instance, larger variety of products manufactured at the macro level.

Following the nomenclature of classic IO models, when establishing the total demand on products of *i* sector, it is possible to calculate the regional technical ratios, as follows: $a_{ij}^R = x_{ij}^R / X_j^R$, where $x_{ij}^R = x_{ij}^{RR} + x_{ij}^{ZR}$ is the products consumption in *i* sector needed in production of *j* sector of *R* region, consisting of products made in (x_{ij}^{RR}) and outside (x_{ij}^{ZR}) the region (Miller, Blair, 2009, pp. 76-80). When having the $\mathbf{A}^R$ matrix of regional direct input ratios it is possible to estimate the influence of final demand of *R* region on the global production of sectors on national level: $\overline{\mathbf{X}}^R = (\mathbf{I} - \mathbf{A}^R)^{-1}\mathbf{Y}^R$.

Regional IO models may relate to a single, two or more regions in mutual relationships. In order to illustrate the simultaneously multiregional connections it is possible to assume the structure, as follows:

$$\aleph = \left[\begin{array}{c|c} \mathbf{X^{RR}} & \mathbf{X^{RZ}} \\ \hline \mathbf{X^{ZR}} & \mathbf{X^{ZZ}} \end{array}\right], \tag{4}$$

where: $\mathbf{X^{RR}}$ indicates the flow in *R* region, $\mathbf{X^{RZ}}$ indicates the flow from *R* to *Z* region, $\mathbf{X^{ZR}}$ indicates the flow from *Z* to *R* region, and $\mathbf{X^{ZZ}}$ indicates the flow outside *R* region.

When considering the regional economy of two regions and 2 sectors, the global production can be defined as:

$$X_i^R = x_{i1}^{RR} + x_{i2}^{RR} + x_{i1}^{ZR} + x_{i2}^{ZR} + Y_i^R . \tag{5}$$

Further, it is possible to define the interregional IO model:

$$\left\{\left[\begin{array}{c|c} \mathbf{I} & \mathbf{0} \\ \hline \mathbf{0} & \mathbf{I} \end{array}\right] - \left[\begin{array}{c|c} \mathbf{A^{RR}} & \mathbf{A^{RZ}} \\ \hline \mathbf{A^{ZR}} & \mathbf{A^{ZZ}} \end{array}\right]\right\} \left[\begin{array}{c} \mathbf{X^{R}} \\ \hline \mathbf{X^{Z}} \end{array}\right] = \left[\begin{array}{c} \mathbf{Y^{R}} \\ \hline \mathbf{Y^{Z}} \end{array}\right], \tag{6}$$

where: $\mathbf{A^{RZ}}$ and $\mathbf{A^{ZR}}$ indicate the transactional ratios.

2.3. Possible applications of IO in the health sector - National Health Accounts (NHA)

Health and health policy recently became transnational, global dimension, because of the role and the functions of solving health problems common to the population. In the modern system, the dilemma connected with the optimal allocation of limited resources is one of the fundamental problems in decision making involving the health policy.

Implementation of the System of Health Accounts (SHA) has been launched by the OECD Member States in order to support proper organization and analysis of health data. This implementation increased the transparency interrelated methods of performance and financing services for individual goods in health, providing services, through a comprehensive and coherent synthesis of health-related transactions. Assessment of the level of expenditure on health in one country allows comparing the size of this expenditure with other countries and is often used to draw conclusions about the effectiveness of functioning of the health system.

The problems in system construction result from the specifics of the health sector. These obstacles are connected with the measurement methods, data collection and the interpretation of results. National systems aim at creating common, country-specific classification methods of health funding, which allowed making international comparisons of these values, estimating trends and indicating factors affecting these value.

System of Health Accounts provides a common structure for health expenditures and methods of financing. SHA answers three key questions:

- where did the funding come from,
- where are the funds directed,
- what kind of services are performed and what type of goods are delivered.

SHA is organized around a triaxial ranking system of health expenditures, settled in the International Classification for Health Accounts (ICHA) and divided into 3 categories:

- sources of funding (ICHA-HF),
- providers of health services (ICHA-HP);
- functions of health care (ICHA-HC).

An example of the SHA table is presented in table 2 below.

Table 2. System of Health Accounts (SHA) in Poland – ex. Functional Classification of Health Care

Functional Classification of Health Care	Total expenditures	General government except social security funds	Social security funds	Private social insurance	Private household out-of-pocket expenditure	Non-profit institutions serving households	Corporations (other than health insurance)	Rest of the world
Services of curative care	20 503 966.50	840 272.20	15 961 347.60	172 500.00	3 529 846.70	-	-	-
Services of rehabilitative care	694 356.10	13 850.50	481 053.10	-	199 452.50	-	-	-
Services of long-term nursing care	2 464 915.30	1 268 939.60	1 177 422.00	-	18 553.70	-	-	-
Ancillary services to health care	1 251 111.10	48 364.30	844 125.90	6 100.00	352 520.90	-	-	-
Medical goods dispensed to out-patients	10 796 588.60	7 339.10	3 700 279.20	-	6 920 540.50	168 429.80	-	-
Non-classified services	912 636.90	56 181.50	507 691.50	-	-	148 763.80	200 000.00	-
Prevention and public health services	1 496 839.10	1 269 785.40	20 349.00	-	-	-	205 415.40	1 289.30
Health administration and health insurance	1 711 477.40	592 681.40	1 114 552.40	4 200.00	-	-	-	43.6
Total current expenditures	39 831 891.00	4 097 414.10	23 806 820.80	182 800.00	11 020 914.30	317 193.60	405 415.40	1 332.90
Health-related functions	35 039 077.70	2 665 661.80	32 236 900.00	-	-	1 820.90	116 983.40	17 711.60
of which investments in health	1 534 444.80	1 522 979.90	-	-	-	-	-	11 464.90
Education and training of health personnel	854.1	-	-	-	-	-	-	854.1
Research and development in health	489 272.10	365 106.90	-	-	-	1 820.90	116 983.40	5 360.90
Food, hygiene and drinking water control	11.9	-	-	-	-	-	-	11.9
Environmental health	19.8	-	-	-	-	-	-	19.8
Administration and provision of social services in kind to assist living with disease and impairment	-	-	-	-	-	-	-	-
Administration and provision of health related cash-benefits	33 014 475.00	777 575.00	32 236 900.00	-	-	-	-	-

Source: Schneider M. (ed.), 2001, A System of Health Accounts in Poland, Warsaw, p. 132.

2.4. Some problems on construction of IO tables in health care

Although there are similarities in construction of the System of National Accounts and the System of Health Accounts tables, it is almost impossible to construct a proper IO table for the purpose of the flow analysis.

The biggest problem regards to the triaxial ranking system and the specification of the system itself. The classification effectively denies the possibility of the flow arrangement, while, when looking on the functional classification, the aggregation of the health expenditures is running differently, then when aggregating data on basis of source of funding. In short, it is not possible to distinguish what amount of expenditures in services of curative care is used by the ancillary services to health care.

When considering the regional IO analysis, it is possible to indicate the categories of expenditures on voivodships level. This division however, does not relieve the condition of flows (for instance between regions) arrangement. What's more, when talking about health system management, one is aware that the funding system is independent on regional level. The amounts of funds directly depend on the National Health Fund (the macro level).

Problem, when conducting IO analysis in health care arises also with the category of final demand – demand for specific products. Transformation of the demand into the manufacturing process may indicate the demand for the level of production of specific products or production of sector that manufactures these products as primary. This leads to a consequence on the shape of the IO table: product to product, sector to sector, or mixed table: product on sector. Generally, it is impossible to construct an IO matrix, which would be an ideal base for all kinds of testing. In addition, the problem of transition from one system to another would not exist if the system was not producing secondary products. This problem could be easily solved when the information on the structure of manufacturing cost is available – such data are not generally available.

2.5. Acquiring the IO of health care sector

The use of models based on the production function allows only the assessment of factors that determine the functioning of the health care system that are significant from a statistical point of view, without indicating units operating in the health system that are ineffective. In the analyses of the productivity not only quantitative information associated with e.g. given number of medical benefits should be considered, but also information reflecting the level of quality of health services and the expected effects of health system functioning. Then, it is possible, firstly, to identify and secondly to point out, which combinations of the inputs are most effective. Choosing the most effective combination between inputs and outputs is the essence of the process of resources allocation (Jewczak, Żółtaszek 2011b, p. 195).

Efficiency research is today regarded as the key element of decision-making, in order to maximize achieved outputs. The concept of the effectiveness is commonly identified with its economic nature and focuses mainly on two aspects (Suchecka 2009, p. 119):

- the technology – an efficient enterprise maximises its production at the given inputs;
- the costs – an efficient company reaches target level of production, while minimising costs.

Achieving efficiency in the economic sense is related to the existence of technical efficiency. In health economics, technical efficiency is defined as the result of hospital service activities relating to the provision of services at a certain time and expenditures (Suchecka 2009, p. 120). Therefore, evaluation of the effectiveness involves determining an appropriate combination of the factors allowing the maximisation of the outputs level.

In measuring the technical efficiency of health care entities, most often, nonparametric methods are used – this approach allows analysing incurred costs and achieved benefits (Vincov 2005).

Data Envelopment Analysis (DEA) is a nonparametric method of acquiring efficiency that compares units with top counterparts. Nonparametric methods also do not require any *a priori* assumptions towards the function form of the relationship between the variables – evaluation is made only on the basis of the available data. Further, DEA method is based on linear programming methodology for determining the relative efficiency of a set of decision-making units (DMUs). DEA determines the efficiency of each DMU in relation to estimated, possible for all DMUs, production limit. DEA focused on the best results and individual DMU, not on measures of average values. As a result, it is possible to obtain a specific change in inputs and outputs for leading to optimality (in Pareto sense).

The literature identifies two main types of DEA models:

- with fixed effects of scale (constant returns-of-scale – CRS),
- with variable effects scale (variable return-of-scale – VRS).

Both approach results indicates the same set of effective DMUs.

Depending on the model CRS/VRS different information is obtained. Using the CRS model an index of total value of technical efficiency is received. Using the VRS approach, the indicator will present the level of pure technical efficiency (Jewczak, Żółtaszek 2011b, p. 197).

DEA models can be differently oriented: on inputs or outputs. In the first case, the method defines the efficiency frontier by estimating, for each DMU, the maximum possible reduction in the level of expenditures, while maintaining the same level of the results. In the case of the second variant, DEA seeks the maximum, proportional increase in production levels of the outputs, while maintaining the same level of the inputs. The analysis results allow determining the effectiveness of individual DMU in 0-1 interval (Suchecka 2009, pp. 129-130) – DMU reaching a score of 1 is relatively the most effective. When scoring less than 1, DMU should be described as relatively inefficient.

3. Some results on inputs/outputs

3.1. Basic IO analysis in health care

Let us assume that table 3 presents the hypothetical 3-sectoral health care system, in which patients are given 3 types of services: curative care, rehabilitative care and long-term nursing care. Services are interpreted in monetary terms in thousands of zlotys. For each service, information on final and total demand, value added, and global value is known. Following the order of IO analysis, matrix of direct input ratios (**A**) has been estimated, of which results are also presented in table below (table 3 also presents the indirect input ratios).

As results of input-output ratios show, the sums of columns of services equal: 0.50 for HC.1, 0.76 for HC.2 and 0.68 for HC.3. In each case, the costs of resources of services from other categories, is only a part of costs of production unit of a category. Using the IO ratios in the analysis, it is easy to predict the future value of inputs, when, for instance, the production of first category increases tenfold.

Table 3. Hypothetical IO system – simplification

	Intermediate demand			Final demand (Y_i)	Total demand (X_i)
	Services of curative care (HC.1)	Services of rehabilitative care (HC.2)	Services of long-term nursing care (HC.3)		
Services	366.00	713.70	823.50	1939.80	4392.00
	1098.00	210.45	1427.40	658.80	2287.50
	732.00	823.50	219.60	1610.40	3623.40
Value added (V_j)	2196.00	539.85	1152.90	3888.75	
Global value (X_j)	4392.00	2287.50	3623.40		10302.90
A	0.08	0.31	0.23		
	0.25	0.09	0.39		
	0.17	0.36	0.06		
Indirect input ratios	0.50	0.24	0.32		

Note: values for services, demand, value added and global value expressed in thousands zlotys.

Source: developed by Authors.

Table 4. Changes in inputs and production

IO ratios	New level of production	New level of inputs
0.08	43920.00	3660.00
0.25		10980.00
0.17		7320.00

Source: developed by Authors.

3.2. Productivity assessment

Any analysis on the condition of health care systems usually begins with the description of changes that occurred in recent years. Table 5 below shows the chain indices calculated for years 2008-2012, and the annual average percentage change in the levels of expenditures.

Table 5. Changes in health care expenditure levels in Poland by their function

Health care expenditure by function	2009/ 2008	2010/ 2009	2011/ 2010	2012/ 2011	Annual average % change
Services of curative care (HC.1)	1.11	1.02	1.04	1.11	6.74%
Services of rehabilitative care (HC.2)	1.14	1.13	1.02	1.15	10.61%
Services of long-term nursing care (HC.3)	1.08	1.15	1.08	1.04	8.57%
Ancillary services to health care (HC.4)	1.18	1.01	1.08	1.10	9.11%
Medical goods dispensed to out-patients (HC.5)	1.09	1.01	1.04	1.05	4.56%
Prevention and public health services (HC.6)	1.08	0.94	1.04	1.08	3.37%
Health administration and health insurance (HC.7)	0.94	0.97	1.27	0.99	3.37%
Investments in health (HC.R.1)	1.12	1.02	1.08	1.13	8.71%
Education and training of health personnel (HC.R.2)	1.14	1.04	1.03	1.08	7.01%
Research and development in health (HC.R.3)	1.34	1.12	1.22	0.95	14.74%
Food. hygiene and drinking water control (HC.R.4)	1.01	0.98	1.06	1.30	8.29%
Administration and provision of social services in kind to assist living with disease and impairment (HC.R.6)	1.07	1.03	0.97	1.11	4.52%
Administration and provision of health related cash-benefits (HC.R.7)	1.10	1.04	1.02	0.92	1.53%

Source: developed by Authors on the basis of EUROSTAT statistical data.

Considering some fluctuations in the values of indices, average annual percentage change shows that the level of expenditures (by its function) increased in time. The highest average annual expenditures change was observed in the field of research and development in health (HC.R.3) – 14.74%, the lowest in administration (HC.R.7) – 1.53%.

In the research on productivity inputs and outputs were categorized as follows:

1. the inputs consisted of:
    a. number of beds,
    b. number of doctors,
    c. number of nurses.

2. the outputs consisted of:
   a. number of patients treated during the year,
   b. man-days of treatment.

On the basis of the variables listed above, the productivity levels were assessed – in this research an input-orientated CSR approach was used. Initial results for the changes in inputs, outputs and productivity levels were presented in table 6. Looking at the annual average percentage change it could be observed that the inputs grew since the 2008 – on average annual increase was 3.06%. While the inputs continued to increase in the analysed period, the outputs and the productivity on average decreased – outputs were decreasing annually by 0.17% and the productivity of health care sector by 0.62% (assuming the unidirectional change rate).

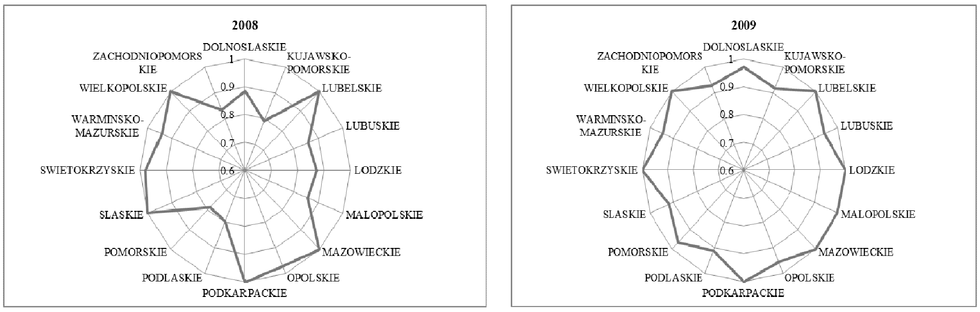
Table 6. Single base indices (2008=100), changes in inputs, outputs and productivity levels of health care in Poland, and annual average % change

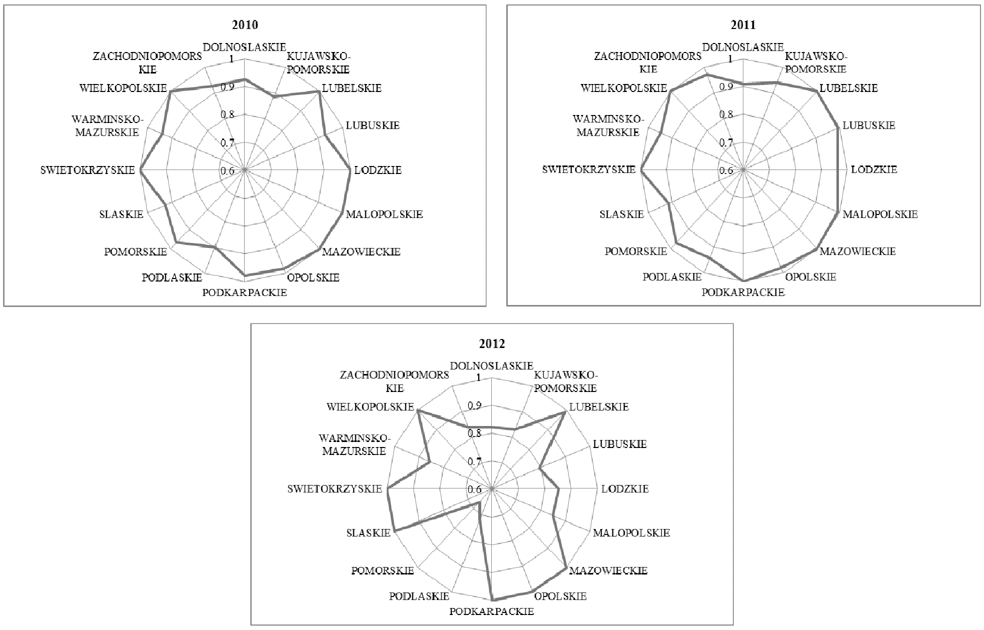
Specification	2008	2009	2010	2011	2012	Annual average % change
inputs	1.00	1.02	1.05	1.09	1.13	3.06%
outputs	1.00	1.00	0.97	0.98	0.99	-0.17%
productivity	1.00	1.06	1.05	1.07	0.98	-0.62%

Source: developed by Authors on the basis of EUROSTAT statistical data.

Looking more detailed at the productivity, during the research it was possible to calculate the productivity of health entities at the regional level (fig. 1). The most diverse year, as the productivity is concerned, was the 2008 and 2012, the less varied was the 2011. The figure 1 below indicates also the changes in regions' productivity changes in time – regions with constant, effective productivity were: Mazowieckie and Wielkopolskie.

Figure 1. Productivity levels of health entities in 2008-2012



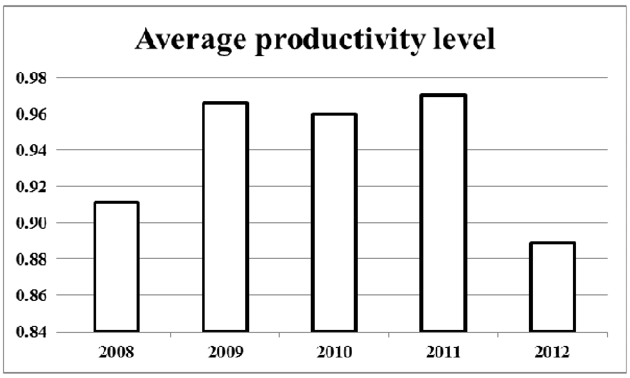


Legend: value 1 indicates the most effective region; any values below this level indicate the ineffective region.

Source: developed by Authors on the basis of EUROSTAT statistical data.

Summing up the research on the inputs/outputs an their relation in the health care sector, figure 2 indicates the total, average annual productivity. Although it was possible to mention regions with effective productivity, in Poland, from 2008 to 2012 the health care system was ineffective. As it was stated earlier the less productivity diverse period was 2011, and the figure below indicated that this was the best year, on average.

Figure 2. Productivity levels of health entities in 2008-2012



Source: developed by Authors on the basis of EUROSTAT statistical data.

4. Conclusions and discussion

Research indicated that it is possible to run an input/output analysis in health care; however it is not possible to conduct the research in the sense of classical IO analysis. This IO analysis concerns only the research on productivity and effectiveness of the health care. The major problem with the analysis derives from the database construction. Both at the macro and regional levels, there are no information on flows of health products or monetary values for products, flows that would allow conducting a typical input and output analysis.

Many authors (e.g. Sargento, 2009), especially on regional level, discuss on some methods that could be possible to use in data disaggregation. Firstly, following Isard and Bramhall [1960], it is possible to estimate a gravity model to identify the flow:

$$x^{rs} = G\frac{(P^r)(P^s)}{(\delta^{rs})^{\alpha}}, \qquad (7)$$

where: x^{rs} – indicates the export from origin r to destination s, G represents the constant of proportionality and P^r and P^s express the r and s population, δ^{rs} shows the spatial distance between the origin and destination of the flow and the α enhance the flexibility of the of the gravity model (this parameter should be estimated). Research also point out the need of testing in the analysis for the spatial dependence. Gravity model assumes that locations are completely independent – the assumption, which according to the first Tobler's law is false. The exploration moved towards spatial models (e.g. Spatial Autoregressive Model or Spatial Error Model). Both approaches allow incorporating a spatial weights matrix **W**, which could indicate for the spatial dependency (see: Suchecki, 2010, pp. 238-251). Using spatial modelling enables to establish the influence in the flow resulting from the neighbouring scheme (described by the **W** matrix) of different regions.

In estimating the regional flows some researchers use the location quotients (*LQ*) (see: Jewczak, Żółtaszek 2011a, p. 90). Within this approach, the possible flow of services constructions results from the measure properties. While comparing the regional to national structure of production, it is possible on the basis of *LQ* values to establish, when a region is self-sufficient and could even export the production to his neighbours, or needs to import goods and services.

Major final remark that discourages from using the IO analysis in the health care sector derives from the health sector itself: the inputs in i field/service category is not an output in j's.

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Streszczenie

ZASTOSOWANIE ANALIZ INPUT-OUTPUT W SEKTORZE OPIEKI ZDROWOTNEJ

Wspieranie się analizami ekonomicznymi w badaniach stanu systemu opieki zdrowotnej, dziś już nie dziwi nikogo. Trendy, jakie rysują się na przestrzeni lat fluktuują przez techniki oceny programów zdrowotnych – pod kątem ich efektywności, kosztów lub użyteczności świadczeń dla pacjentów, poprzez metody oceny skłonności do współpłacenia za świadczenia *zdrowotne oraz zapotrzebowania na świadczenia medyczne. Wiele miejsca poświęca się analizom kształtu systemu opieki zdrowotnej: wysokości składki na Narodowy Fundusz Zdrowia, zmianie sposobów zarządzania systemem, zarówno na szczeblu mikro, jak i makro, czy procesom restrukturyzacyjnym. Każda metoda, która pozwala wykazać zależności, wskazać słabe/mocne punkty systemu opieki zdrowotnej jest mile widziana przez twórców polityki zdrowotnej.*

Celem artykułu jest próba zastosowanie modeli typu input-output w analizach stanu sektora opieki zdrowotnej w Polsce. Budowa takich modeli input-output bazuje na danych obserwowanych dla wyszczególnionego, różnie definiowanego obszaru – może dotyczyć, kraju, regionu, gminy, itp., stąd przy odpowiedniej konstrukcji bazy danych możliwe jest zbadanie przepływów świadczeń zdrowotnych w kategoriach finansowych – na przykład wyrażonych w złotych. Część artykułu zostanie poświęcona rozważaniom teoretycznym nad modelami wykorzystania modeli input-output oraz problemów, które ich wykorzystanie może przysporzyć.

Słowa kluczowe*: modele input-output, sektor opieki zdrowotnej, analiza przepływów*