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## **New Economics in the Health Care Sector**

### INTRODUCTION

Economic space is a part of geographical space where people live and carry out not only production and consumption but also service and social activities. Those activities may be of the punctual, linear or areal nature but in the health care sector spatial relationships are the most vital. Attempts to promote and develop new directions of knowledge are of the major significance in the age of development of Knowledge-Based Economy. The development of information science broadens the scope of its uses and particularly important information science tools are useful in the processes of managing various resources. The management of the health care sector requires efficient actions in its information and communication as well as financial aspects. Research within the framework of new economics is becoming important in the health care sector where it is essential to use statistics and spatial econometrics tools in the analysis of cross-sectional and temporal health care data.

Along with several other factors, availability of medical services is also determined by the number of physicians and the number of nurses per specific population size<sup>1</sup>. To a substantial degree, that ratio affects availability of health services, while information and information technologies are of the cardinal importance to patients. They may contribute to enhanced quality and effectiveness of taken actions. The use of IT tools in the public health care sector supports the process of making decisions and taking actions aimed at assessing improvement in the quality of public services meant for citizens as patients.

### TECHNICAL PROGRESS

Technical progress, especially in health care, plays a vital role in managing staff and is becoming more and more important as a factor influencing the effectiveness and quality of treatment because it is the very factor that puts health

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<sup>1</sup> Based on the OECD report regarding health care in Europe in 2010, Poland ranked 29th with 2.2 physicians per one thousand inhabitants and the 26th with 5.2 nurses per one thousand inhabitants among 30 countries; [www.euroinfo.org.pl](http://www.euroinfo.org.pl).

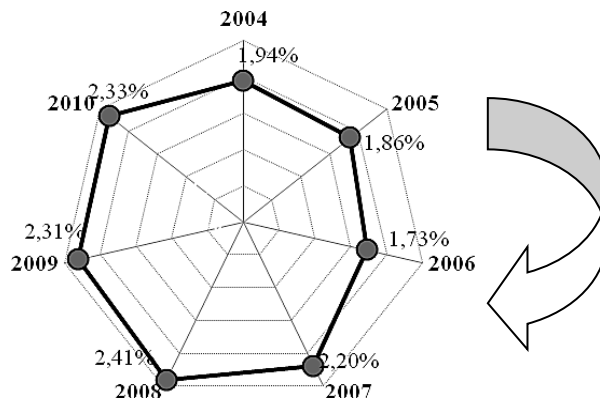
care on its path to development. In that case, technical progress is understood as changes in the technology and organization of health care leading to an increase in the effectiveness of management processes.

Technical progress results in an increase in treatment that is not due to an increase in resources of medical personnel as factors of production but to the use of state-of-the-art medical equipment. Ultimately, it leads to a growth in the number of satisfied patients and improved living standard of citizens. A synthetic way to assess changes in the effectiveness of treatment processes arising from technical progress is to evaluate an increase in the total productivity of treatment factors. Nowadays knowledge and experience of medical personnel are treated as an economic resource as they are a basis allowing to come up with ideas and innovations.

The performance of regional analyses as a type of research within modern economics requires employing available information technology tools. The effective use of statistical database resources is enabled by applying appropriate programs developed for spatio-temporal analyses.

### HEALTH CARE EXPENDITURES

Health care expenditures were growing steadily, which may be reflected by the fact that in 2004 they accounted for a mere 55.9% of those made in 2010. In 2004 state budget expenses on health care accounted for 1.94% of the whole budget, whereupon in the subsequent two years (2005–2006) a drop in the share of those expenditures and – from 2007 to 2008 – an increase up to 2.41% were observed. Yet, 2009 saw another fall in the share of those expenditures by 0.1 pp (figure 1).



**Figure 1. Share of state budget health care expenditures**

Source: own work based on calculations using the Local Data Bank (LDB).

Nevertheless, in 2010, as compared with 2004, an increase in the share of expenditures by as much as 0.39 pp was noted, which may be considered positive if those were expenditures connected with e.g. the purchase of modern equipment or medicines. From the economic point of view, the financial condition of medical staff also improved, especially in the case of physicians being a basic link in efficiently functioning health care.

### EXAMINATION OF SPATIAL RELATIONSHIPS

The empirical analysis is based on a sample of data for 16 voivodships from 2004 to 2010. On the basis of available information contained in *Statistical Bulletins of the Ministry of Health* and publications entitled *Basic Health Care Data* for 2005–2012, a databank was prepared to analyse selected variables that may affect an economic situation in the regional analysis of public health care. The list of variables for specific examined voivodships was as follows:

- $X_{11}$  medical specialists (consultants) in the public sector,
- $X_{12}$  value of medical equipment<sup>2</sup>,
- $X_{13}$  medical equipment in general public hospitals (biochemical analyser, gamma camera, lithotripter, linear particle accelerator, X-ray device with laparoscope, CT scanner, MRI device),
- $X_{14}$  nurses,
- $X_{15}$  midwives,
- $X_{16}$  health care expenditures of local government units (LGUs),
- $X_{17}$  number of beds in hospitals and branches,
- $X_{18}$  physiotherapy and rehabilitation specialists,
- $X_{19}$  patients, including interdepartmental movement.

The significance of correlational relationships between variables was examined based on a determined linear correlation coefficients matrix of the examined variables for specific years in the 2004–2010 period. That enabled to verify the statistical significance of voivodships' features' relationships and assign variables to the set of the model's explanatory variables (Table 1).

The correlation coefficients of the used observations for 16 voivodships in the period of 7 years (for  $n = 16$ ) allowed to determine the critical value (with a bilateral 5% critical region) = 0.4973. Only for the ( $X_{18}:X_{12}$ ) variable of 2004 the correlation coefficient was at 0.4053 and was below the critical value, i.e. the linear relationship between the examined features proved to be statistically insignificant. The other coefficients were above the critical value, hence a hypothesis of the significance of linear correlation between examined features was assumed. Based on the values of correlation coefficients provided in the table,

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<sup>2</sup> Informacja o wynikach zakupu sprzętu medycznego, [www.nik.gov.pl](http://www.nik.gov.pl).

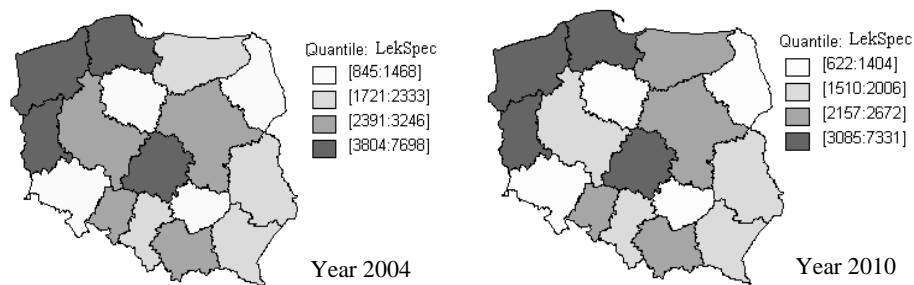
a hypothesis of the significance of linear correlations between features ought to be assumed. Values of all the coefficients exceed the critical value (0.4973). The strongest correlation relationship occurred between the number of hospital beds and employed nurses needed to take care of treated patients. The correlation coefficient between nurses and medical specialists working in the public sector ranked second.

**Table 1. Linear correlation analysis, matrix of coefficients for 2010 data**

X11	X12	X13	X14	X15	X16	X17	X18	X19
1	0.9290	0.9512	0.9848	0.9294	0.8779	0.9608	0.9257	0.9421
	1	0.8813	0.9429	0.9240	0.8976	0.9077	0.9210	0.9204
		1	0.9677	0.9128	0.8599	0.9802	0.8936	0.9516
			1	0.9513	0.8706	0.9863	0.9231	0.9635
				1	0.8141	0.9510	0.8906	0.9618
					1	0.844	0.8502	0.8945
						1	0.9036	0.9744
							1	0.9223
								1

Source: own work based on a prepared set of data using the Gretl program.

Spatial units (voivodships in this case) affect one another. Distance or adjacency influences the strength of spatial interactions. The presentation of data on the map was limited to the analysed variable concerning the number of medical specialists in voivodships in the initial and final periods of analysis. Division into quantile groups enables to capture changes taking place over the period of seven years. A fall in employment was observed associated with employment restructuring in the health care system. There were two voivodships whose assignment to quantile groups changed, i.e. in 2004 the warmińsko-mazurskie voivodship was in the second group and in 2010 – in the third group, while the opposite situation occurred for the wielkopolskie voivodship (figure 2).



**Figure 2. Grouping map for numbers of medical specialists working in the public sector in 2004 and 2010**

Source: own work based on data using the GeoDa program.

Spatial data require specialist methods of analysis allowing to avoid problems resulting from the introduction of spatial effects in an econometric model (e.g. spatial autocorrelation). Further analysis concerns correlational relationships between observed values of one variable at different points of the space, called spatial autocorrelation<sup>3</sup>, as the value of an observed variable may depend on earlier observations.

Adjacency or distance of the studied spatial units as the values of features in different locations (voivodships) is taken into account by means of a spatial weights matrix<sup>4</sup>. The spatial weights matrix is selected *a priori* – the use of two different weights produces different results. Of course, the application of the simplest spatial weights matrices is postulated. This study uses a spatial weights matrix in the form of the queen configuration, i.e. neighbours in all adjacent locations.

The lack of symmetry of boundaries, however, interferes with Moran's I statistic results<sup>5</sup>.

The presence of spatial autocorrelation was verified based on the calculated Moran's I statistic for data selected for the model on the basis of statistical significance for the variables ( $X_{11}$ ,  $X_{12}$ ,  $X_{14}$ ,  $X_{16}$  and  $X_{17}$ ) in specific years. Drawn dispersion graphs allow to (more precisely than based on maps of variables' values) identify the type of spatial autocorrelation.

The gathering of observations in the 1st or 3rd quarter (High-High, Low-Low) indicates the presence of positive autocorrelation. The gathering of observations in the 2nd or 4th quarter (High-Low, Low-High) shows negative autocorrelation.

The global statistic indicates the occurrence of spatial relationships for a given variable in the whole studied area. Therefore, the following hypotheses are examined for global Moran's I statistic:

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<sup>3</sup> Autocorrelation measures have been developing as early as since the mid-20th century with Moran's I autocorrelation coefficient being the most popular one. Positive autocorrelation – spatial gathering of high or low values of observed variables (formation of clusters). Negative autocorrelation – high values are adjacent to low ones and the other way round, creating a kind of chess-board. Thus, it can be said that positive autocorrelation is a spatial gathering into clusters, while negative autocorrelation is characteristic of the dispersion of values.

<sup>4</sup> Spatial weights matrices include: adjacency weights matrices (two areas are adjacent if they have a common boundary, two areas are  $n$ -order adjacent if it is necessary to cross at least  $n$  boundaries to get from one to the other), i.e. the closest adjacency or adjacency of boundaries, as well as matrices of geographical or economic distance weights.

<sup>5</sup> E. Antczak, K. Lewandowska-Gwarda, *Zastosowanie metod eksploracyjnej analizy danych przestrzennych w badaniu poziomu umieralności w Polsce* [w:] *Klasyfikacja i analiza danych – teoria i zastosowania*, red. K. Jajuga, M. Walesiak, Taksonomia 16, Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu, Wrocław 2009, s. 333–339; T. Kossowski, *Metody i modele ekonometrii przestrzennej* [w:] *GIS platforma integracyjna geografii*, red. Z. Zwoliński, Wydawnictwo Naukowe, Pracownia Analiz Geoinformacyjnych, Uniwersytet im. A. Mickiewicza w Poznaniu, Poznań 2009, s. 149–150.

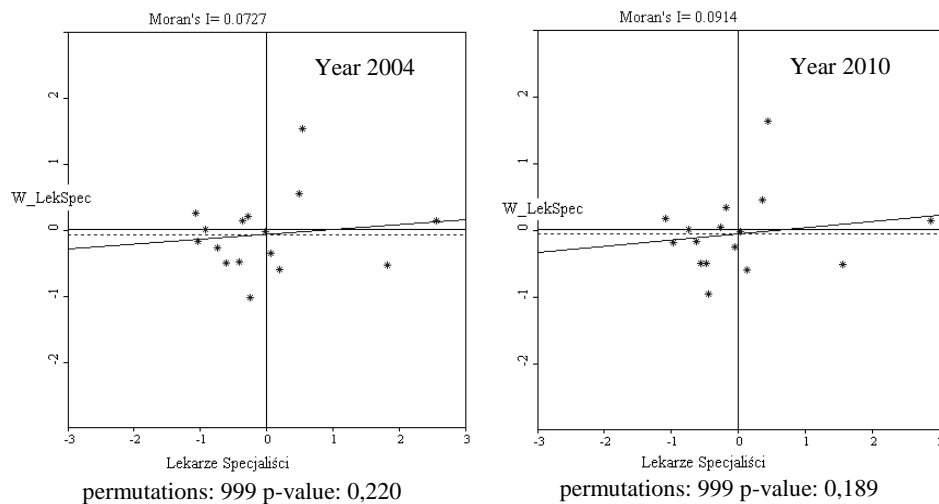
$H_0$ : observed values are distributed in a random manner among specific locations (no spatial autocorrelation),

$H_1$ : observed values are not distributed in a random manner among specific locations (spatial autocorrelation).

If adjacent spatial objects are similar to one another, they form clusters and the value of the statistic is positive. If objects are different (their spatial distribution is irregular, they do not form clusters), the value of the statistic is negative.

When analysing the dispersion graph, the significance of Moran's I statistic was verified applying the 999-permutation test<sup>6</sup>.

The calculated value of global Moran's I statistic at 0.0727 and p-value at 0.22 (above 0.05) indicate the insignificant occurrence of positive spatial autocorrelation characterizing the number of medical specialists working in the public sector in 2004. For 2010, the value of global Moran's I statistic at 0.0914 and p-value at 0.189 (above 0.05) also indicate the insignificant occurrence of positive spatial autocorrelation. Voivodships do not form clusters in respect of similar values of the studied feature (figure 3).



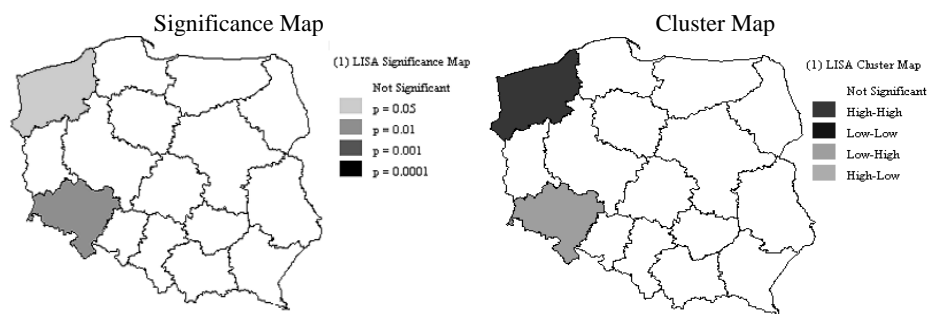
**Figure 3. Dispersion graph – global Moran's I statistic in 2004 and 2010**

Source: own work, as in Figure 2.

The LISA local statistic was also checked<sup>7</sup>. It shows spatial relationships of a given variable in a specific location with its surroundings, i.e. with values of

<sup>6</sup> The value of Moran's I statistic is in the  $[-1, 1]$  interval. It usually has the value of  $|I| < 1$ . Research into the features of its distribution produced a precise distribution of Moran's statistic and led to the use of a randomized version of the test. The higher the  $p$  value occurs, the less likely the actual presence of autocorrelation is. That rule allows to reject the  $H_0$  hypothesis of the lack of spatial autocorrelation for  $p < 0.05$  at  $\alpha = 0.05$ .

that variable in adjacent locations. The high significance of a tendency to form clusters characterizes the Zachodniopomorskie voivodship, while relatively low clustering is typical of the Dolnośląskie voivodship. Based on the maps of clusters of LISA local statistics for both 2004 and 2010, it should be pointed out that high values of the variable gather in the Zachodniopomorskie voivodship. In the Dolnośląskie voivodship, the number of medical specialists in the public health care is relatively low. Results of LISA local statistics for 2004 and 2010 coincide on the maps (Figure 4).



**Figure 4. LISA local statistics for 2004 and 2010**

Source: Own work, as in Figure 3.

The calculation of statistics for the selected group of variables in specific years enables to draw the so called significance map and cluster map. Statistics for all the variables as well as significance and cluster maps are presented in Table 2.

Based on that, it can be stated that in the studied years the insignificant occurrence of, both positive and negative, spatial autocorrelation was not observed. On the basis of the cluster map of LISA local statistics for 2004, it should be noted that high values of the variables cluster in the Zachodniopomorskie voivodship for the numbers of medical specialists and nurses. In the case of the Dolnośląskie voivodship the number of medical specialists, value of equipment, number of nurses, number of hospital beds and health care expenditures of LGUs are characterized by a relatively low value of the clustering of variables, while the cluster of low health care expenditures of LGUs included also the Zachodniopomorskie voivodship. A higher significance of a tendency to form clusters characterizes the Dolnośląskie voivodship for all the studied variables and, additionally, the Wielkopolskie voivodship (but solely for equipment value), than the Zachodniopomorskie voivodship for the values of variables con-

<sup>7</sup> The local indicator of spatial association (LISA) shows the statistical significance of clusters of similar values in adjacent locations. It allows detailed insight into the structure of spatial distribution of a variable in an area.

cerning the number of medical specialists, nurses and health care expenditures of LGUs, and the Podkarpackie voivodship only for the value of variable concerning the value of equipment.

The comparison of the local statistics for 2010 allows to reveal an identical, higher tendency to form clusters by the Dolnośląskie voivodship than the Zachodniopomorskie voivodship for all the studied variables. Based on the map of clusters, it should be pointed out that high values of the variables gather in the Zachodniopomorskie voivodship, except for the value of variable concerning the value of devices among the studied variables.

**Table 2. Global Moran's I statistics and clusters of LISA local statistics for variables in 2004 and 2010**

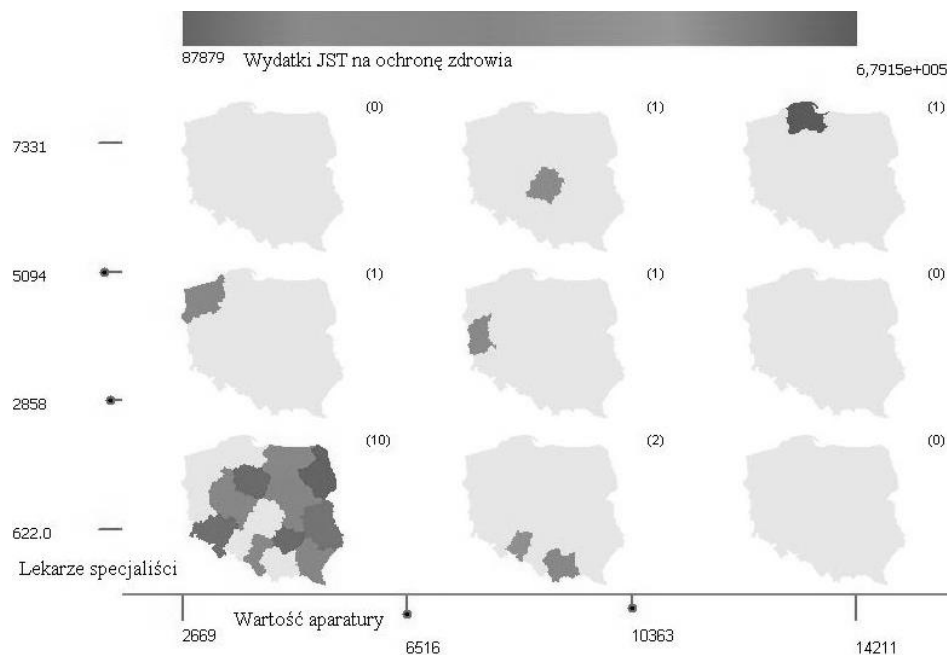
Years	Statistic/ Map	X11	X12	X14	X16	X17	
2004	Moran's I	0.0727 (p=0.220)	-0.1113 (p=0.395)	0.0250 (p=0.290)	-0.0952 (p=0.477)	-0.0009 (p=0.352)	
	Significance Map	Not significant	(14 voiv)	(13 voiv)	(14 voiv)	(15 voiv)	(15 voiv)
		p=0.05	Zachodniopomorskie	Podkarpackie	Zachodniopomorskie		
		p=0.01	Dolnośląskie	Dolnośląskie, Wielkopolskie	Dolnośląskie	Dolnośląskie	Dolnośląskie
	Cluster Map	Not significant	(14 voiv)	(13 voiv)	(14 voiv)	(15 voiv)	(15 voiv)
		High-High	Zachodniopomorskie		Zachodniopomorskie		
		Low-Low		Podkarpackie			
		Low-High	Dolnośląskie	Dolnośląskie	Dolnośląskie	Dolnośląskie	Dolnośląskie
		High-Low		Wielkopolskie			
	2010	Moran's I	0.0914 (p=0.189)	-0.1538 (p=0.319)	0.0139 (p=0.344)	0.0056 (p=0.341)	
Significance Map		Not significant	Not significant	(14 voiv)	(14 voiv)	(14 voiv)	(12 voiv)
		0.05	0.05	Zachodniopomorskie	Zachodniopomorskie	Zachodniopomorskie	Zachodniopomorskie
		0.01	0.01	Dolnośląskie	Dolnośląskie	Dolnośląskie	Dolnośląskie
		Not significant	Not significant	(14 voiv)	(14 voiv)	(14 voiv)	(14 voiv)
Cluster Map		High-High	High-High	Zachodniopomorskie		Zachodniopomorskie	Zachodniopomorskie
		Low-Low	Low-Low				
		Low-High	Low-High	Dolnośląskie	Dolnośląskie, Zachodniopomorskie	Dolnośląskie	Dolnośląskie
		High-Low	High-Low				

Source: own work, as in Figure 2 (voiv stands for voivodship).

A relatively low value of the variable occurred in the Dolnośląskie voivodship for all the variables and, additionally, in the Zachodniopomorskie voivodship but only for the value of variable concerning medical equipment.



The most important economic determinant in this analysis was the impact of new technologies (the value of medical devices) on the effectiveness of treatment. Health care expenditures made by LGUs and nurses needed to take care of treated patients, as human capital, as well as equipment in the form of hospital beds were assumed as variables affecting the employment of medical specialists. An example of distribution of data in three-dimensional space (Figure 5).



**Figure 5. Medical specialists, equipment value and health care expenditures of local government units in 2010**

Source: own work based on data using the GeoDa program.

Treatment results may be influenced by medical specialists but an important role is also played by the proper organization of work and provision of appropriate medical equipment<sup>8</sup>. Detailed regional analysis concerning medical specialists in the public health care system was presented at the 2nd Spatial Econometrics Conference<sup>9</sup>.

<sup>8</sup> D. Rozpędowska-Matraszek, *Innowacja jako czynnik istotnie wpływający na skrócenie średniego czasu pobytu pacjenta w szpitalu – analiza według województw* [w:] *Technologie wiedzy w zarządzaniu publicznym '11*, red. J. Gołuchowski, A. Frączkiewicz-Wronka, Prace Naukowe Uniwersytetu Ekonomicznego, Wyd. UE w Katowicach, Katowice 2012, s. 196–214.

<sup>9</sup> D. Rozpędowska-Matraszek, *Analysis of Multidimensional Temporal and Spatial Data Based on the Example of Employment in Health Care in Selected Voivodships of Poland* [w:]

## DYNAMIC PANEL MODEL

The presented study uses an econometric model estimated based on panel data. The number of medical specialists is being modelled. The employment of medical specialists can be treated as a simplification of human capital in voivodships, thanks to which the health condition of voivodships' inhabitants improves. Panel models are characterized by the fact that they comprise the so called group effect, constant in time, characteristic of a given object. The starting point is to identify two components within the random element. Also, a third component can additionally be identified, constant relative to objects, called the temporal effect. In order to examine factors affecting the structure of medical specialists' employment in voivodships, a dynamic panel model was used<sup>10</sup>:

$$y_{it} = \alpha_0 + \gamma \cdot y_{i,t-1} + \mathbf{x}_{it}^T \cdot \boldsymbol{\beta} + (\alpha_i + \varepsilon_{it}) \quad \text{for } i = 1, \dots, N, t = 2, \dots, T \quad (1)$$

where:

$\varepsilon_{it} \sim N(0, \sigma_\alpha^2)$  for each  $i, t$ ,  $\alpha_i$  – group effects (random or non-randomized), then when the  $\alpha_i$  are random, it's  $\alpha_i \sim N(0, \sigma_\alpha^2)$ ,  $\mathbf{x}_{it} = [x_{kit}]_{K \times 1}$  is a vector of explanatory variables of coordinates  $K$ ,  $\boldsymbol{\beta}$  – vector of parameters ( $K \times 1$ ), same for all  $i$  and  $t$ .

Model estimation applied the generalized method of moments (GMM), the most universal one that does not require a large number of assumptions. The form and number of conditions of moments possible to be used in the process of model estimation depend on assumptions concerning correlation between variables  $x_{it}$  and components  $\alpha_i$  and  $\varepsilon_{it}$ .

The collection of macroeconomic data in large panels increased interest among economists in the estimation of dynamic econometric models on panel data. The issue became especially significant in regional studies because the use of panel data to estimate relationships between objects (voivodships) enables to simultaneously receive specific effects for particular objects. Results of the model served as a basis for the following estimations using the STATA program:

- GMM – System dynamic panel-data estimation<sup>11</sup>

$$\hat{X}11_{it} = -77,44^* i + 0,4 \cdot X11_{-1it} - 0,002 \cdot X12_{it} + 0,26 \cdot X14_{it} - 0,0003 \cdot X16_{it} - 0,06 \cdot X17_{it}$$

*Spatial Econometrics and Regional Economics Analysis*, (ed.) B. Suchecki, Acta Universitatis Lodzianis, Folia Oeconomica, No 292/2013, Łódź 2013, s. 105–116.

<sup>10</sup> B. Dańska-Borsiak, *Dynamiczne modele panelowe w badaniach ekonomicznych*, Wydawnictwo Uniwersytetu Łódzkiego, Łódź 2011, s. 78–79.

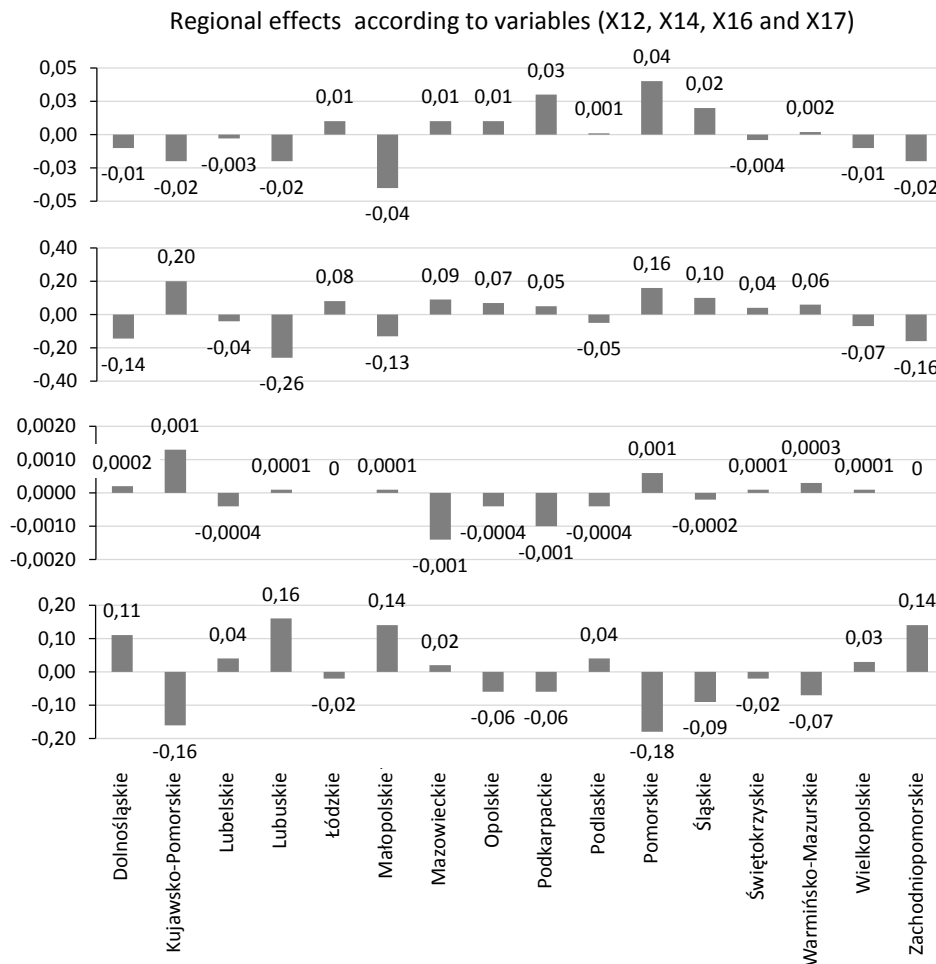
<sup>11</sup> Based on empirical results of the Arellano-Bond autocorrelation test AR(1) -2.806 [p=0.00] and AR(2) 1.891 [p=0.05], it was determined that there was no autocorrelation. The Sargan test at 12.764 [p=0.55] allows to state that over-identifying restrictions are appropriate.

\* – the symbol of significance at the level of 0.1, other parameters at the level of 0.05,  $X11_{-1it}$  – variable lagged by one period (year).

▪ GMM – Random-coefficients regression

$$\hat{X}_{11, it} = -0,005 \cdot X_{12, it}^* + 0,21 \cdot X_{14, it} - 0,001 \cdot X_{16, it} + 0,08 \cdot X_{17, it}^* + \text{reg effects}_i$$

Calculated parameters of both the models do not demonstrate considerable deviations except for a change of the sign at the variable concerning the number of hospital beds. The delayed endogenous variable, as the explanatory variable in the model, is correlated by the so called group effects that reflect the effect of operation of constant factors specific for a given voivodship. Based on received specific effects for particular variables, deviations from the mean were calculated (figure 6).



**Figure 6. Deviations from the mean of specific group effects**

Source: own work based on model results.

Regional effects for the value of medical devices turned out to be insignificant for as many as five voivodships: Dolnośląskie, Lubelskie, Mazowieckie, Opolskie and Warmińsko-Mazurskie. The situation was better in the case of employed nurses as only three voivodships – Lubuskie, Wielkopolskie and Zachodniopomorskie – did not demonstrate statistical significance; it was similar for health care expenditures of LGUs but those were the Kujawsko-Pomorskie, Lubuskie and Pomorskie voivodships. In the case of variable concerning the number of hospital beds, regional effects appeared to be significant only for nine voivodships (Dolnośląskie, Lubelskie, Lubuskie, Łódzkie, Małopolskie, Mazowieckie, Podlaskie, Pomorskie and Zachodniopomorskie).

The largest deviations of effects for the variable of the value of medical devices occurred for the Pomorskie and Małopolskie voivodships, and for the employment of nurses – in the Kujawsko-Pomorskie and Pomorskie voivodships. The lowest differentiation of effects concerns health care expenditures of LGUs. The highest deviations from the mean for the number of beds were noted for the Lubuskie, Małopolskie and Zachodniopomorskie voivodships.

Negative values of coefficients indicate that the value of purchased equipment and health care expenditures of LGUs, to a minimal degree, affect a decrease in the employment of medical specialists and, to a slightly larger degree, a decline in the number of hospital beds.

An increase in the employment of nurses affects an increase in the employment of medical specialists in the public health care system, which does not improve the financial situation in facilities (employment of specialists entails considerable costs).

## CONCLUSION

The regional policy serves to remove regional disproportions, i.e. not only economic but also social differences. Thanks to a great number of connections with its environment, every voivodship, as a territorial unit, is an open system, thus susceptible to external influences. From the point of view of regional development, however, it is vital to maintain spatial cohesion in health care, while results received based on the performed analysis reveal diversification.

## REFERENCES

- Antczak E., Lewandowska-Gwarda K., *Zastosowanie metod eksploracyjnej analizy danych przestrzennych w badaniu poziomu umieralności w Polsce* [w:] *Klasyfikacja i analiza danych – teoria i zastosowania*, red. K. Jajuga, M. Walesiak, Takso-

- nomia 16, Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu, Wrocław 2009.
- Bank danych Lokalnych, [www.stat.gov.pl](http://www.stat.gov.pl).
- Dańska-Borsiak B., *Dynamiczne modele panelowe w badaniach ekonomicznych*, Wydawnictwo Uniwersytetu Łódzkiego, Łódź 2011.
- Informacja o wynikach zakupu sprzętu medycznego*, [www.nik.gov.pl](http://www.nik.gov.pl).
- Kossowski T., *Metody i modele ekonometrii przestrzennej* [w:] *GIS platforma integracyjna geografii*, red. Z. Zwoliński, Wyd. Naukowe, Pracownia Analiz Geoinformacyjnych Uniwersytet im. A. Mickiewicza w Poznaniu, Poznań 2009.
- Rozpędowska-Matraszek D., *Innowacja jako czynnik istotnie wpływający na skrócenie średniego czasu pobytu pacjenta w szpitalu – analiza według województw* [w:] *Technologie wiedzy w zarządzaniu publicznym '11*, red. J. Gołuchowski, A. Frączkiewicz-Wronka, Prace Naukowe Uniwersytetu Ekonomicznego, Wyd. UE w Katowicach, Katowice 2012.
- Rozpędowska-Matraszek D., *Analysis of Multidimensional Temporal and Spatial Data Based on the Example of Employment in Health Care in Selected Voivodships of Poland* [w:] *Spatial Econometrics and Regional Economics Analysis*, (ed.) B. Suchecki, Acta Universitatis Lodzianis, Folia Oeconomica, No 292/2013, Łódź 2013.
- Rynek instrumentów i urządzeń medycznych w UE*, [www.euoinfo.org.pl](http://www.euoinfo.org.pl).

#### Summary

Technical progress, especially in health care, plays a vital role in managing staff and is becoming more and more important as a factor influencing the effectiveness and quality of treatment because it is the very factor that puts health care on its path to development. In that case, technical progress is understood as changes in the technology and organization of health care leading to an increase in the effectiveness of management processes.

The most important economic determinant in this analysis was the impact of new technologies (the value of medical devices) on the effectiveness of treatment. Health care expenditures made by LGUs and nurses needed to take care of treated patients, as human capital, as well as equipment in the form of hospital beds were assumed as variables affecting the employment of medical specialists.

The empirical analysis the employment of medical specialists is based on a sample of data for 16 voivodships from 2004 to 2010. The presented study uses an econometric model estimated based on panel data. Model estimation applied the generalized method of moments (GMM).

### **Nowa ekonomia w sektorze ochrony zdrowia**

#### *Streszczenie*

Postęp techniczny, zwłaszcza w opiece zdrowotnej, odgrywa duże znaczenie w gospodarowaniu kadrami i jest coraz bardziej istotnym czynnikiem wpływającym na efektywność i jakość leczenia, ponieważ to właśnie on sprawia, że opieka zdrowotna znajduje się na drodze rozwoju. Mianem postępu technicznego określa się w tym przypadku zmiany w technologii i organizacji opieki zdrowotnej, prowadzące do zwiększania efektywności procesów gospodarowania.

W artykule podjęto próbę oceny wpływu innych czynników niż wymogi proceduralne, na strukturę zatrudnienia lekarzy specjalistów w podmiotach publicznych, a mianowicie sprawdzono, jaki jest wpływ nowych technologii (mierzony wartością aparatury medycznej), wpływ wydatków ponoszonych przez jednostki samorządu terytorialnego na opiekę zdrowotną oraz zatrudnienie pielęgniarek potrzebnych do obsługi leczonych pacjentów, czy wpływ infrastruktury technicznej podmiotów medycznych – wyposażenie w łóżka szpitalne.

Analiza empiryczna zatrudnienia lekarzy specjalistów oparta jest na próbie danych dla 16 województw w latach 2004–2010. W prezentowanym badaniu zastosowano model ekonometryczny szacowany na podstawie danych panelowych. Estymację modelu wykonano z wykorzystaniem uogólnionej metody momentów (GMM).