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by

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CONVERGENCE OF HEALTH CARE SYSTEMS OF THE EUROPEAN UNION COUNTRIES IN LIGHT OF QUANTITATIVE STATISTICAL EVALUATION

Abstract

Between countries of the European Union there should occur the process of convergence (understood as the catch – up effect) of their health care systems. There exist theoretical premises and it is as well confirmed by declarations of the European Union institutions, indicating tools which serve this rapprochement of systems (like the open method of coordination). However quantitative evaluation of the level of achieved convergence in this matter meets substantial obstacles, related to the complex character of health care phenomenon, which can only be described by multiple feature models. In the paper has been presented the quantitative evaluation method of convergence grade of health care systems, with help of the complex indicator based on the synthetic variable, aggregating four simple features. Diversification of the synthetic variable has been analyzed and measured with use of standard deviation. The results of the conducted analysis confirm the thesis of increasing in time processes of interstate convergence in health care systems in the European Union.

Key words: health care, health care system, health care policy, health care expenses, convergence, open method of coordination, synthetic variable.

JEL Codes: I13, I18, J18, H51.

1. Introduction

In the European Union processes of interstate convergence between health care systems may occur. Convergence is here understood as "the process of approaching and becoming similar of different systems till homogenous 'new' system emerges" [Sowada, 2003, p. 10-16].

There exist at least two reasons for this phenomenon: first of all the conviction that rapprochement in the means of social policy realization (including health care) influences better exploitation of labor factor, offered by workforce, mobile in the European Union; secondly - socially conditioned tradition of high level of health care in membership countries, which constitutes widely understood European welfare model [Księżopolski, 2005, p. 26-28].

In opinion of the European Union institutions and subject's researchers, the way of securing this convergence may be then open method of coordination, and the common aims in health care for all membership countries should be at least:

- provision of trans-border medical care for people legally moving across the European Union territory,
- uninhibited trans-border medical information flow (formulated in homogenous system of statistic indicators, comparable between different countries),
- unification among countries of conditions for running health care institutions and permission to run such institutions in other countries than the origin membership country,
- organization of medical assistance in case of trans-border health hazards,
- coordination on the European Union level of scientific research in the field of health care [European Commission, 2003; Jorens, 2005, p. 42-46; Sowada, 2003, p. 10-16].

With regard to the complexity and difficulties with qualitative analysis of the progress of such processes there arises the need of synthesized and quantitative evaluation method of the level of obtained convergence in health care. In the paper has been presented the analysis of the degree of statistical convergence (measured with use of standard deviation) for aggregated indicator based on the synthetic variable [Jankowiak, 2010].

2. Research methodology

One of the methods of aggregation for simple indicators are more complex techniques of numerical taxonomy, based on the synthetic variables. They lead to intentional arrangement of multi-feature phenomena and enable conducting comparisons between them [Grabiński, Wydmus, Zeliaś, 1989, p. 7-19; Kolenda, 2006, p. 17-18; Michalski, Dorosiewicz, 1999, p.20-21]. In literature exist many examples of use of indicators based on the synthetic variables to describe social phenomena including the ones occurring in the field of health care [Grabiński, Wydmus, Zeliaś, 1989, p. 84-109; Zeliaś, 2000, p. 126; Wiszniewska, 2008, p. 371-380; Foryś, 2008, p. 381-389; Witkowska, Witkowski, 2008, p. 416-425; Strzelecka, Nieszporska, 2009, p. 91-102]. However the application of taxometric methods in order to evaluate the processes of coordination and convergence in health care in the European Union has not been wider published[1].

Used method of analysis assumes the application of the complex indicator, based on the synthetic variable, originating from aggregation of normalized values of chosen simple indicators from the field of public health. In this approach health care systems of particular membership countries are treated as multi-feature objects, described by set of simple diagnostic features. The most common distinction in literature comprises of the following stages of calculation of synthetic indicator: firstly the choice of simple diagnostic features (indicators), describing research phenomenon; secondly establishing which desired direction should changes of diagnostic features have – do they constitute stimulants or de-stimulants of research phenomenon; thirdly normalization of values of chosen indicators in order to ensure their mutual comparability; fourthly determining the system of weights and finally the choice of aggregation methods of normalized and weighted diagnostic feature in single synthetic variable (synthetic indicator) [Grabiński, Wydmus, Zeliaś, 1989, p.19-35].

As a basis for further aggregation have been chosen four simple indicators, published by Eurostat: public health care expenditures as percentage (%) of the GDP[2], number of practising physicians per 100 000 inhabitants, number of hospital beds for 100 000 inhabitants and infant mortality rate [Eurostat, 2011]. The choice of indicators has been dictated by theoretical premises of good dependence of their values on processes of convergence on basis of open coordination and

[1] Some authors compare diversity of research units, based on the diversity of synthetic variable, but it applies to the different fields [Zeliaś, 2000, p. 134-144; Witkowska, Witkowski, 2008, p. 416-425].
[2] Published by Eurostat as „General government health care expenditures (%GDP)".

correspondence of their diversity in time series, demonstrated in previous analysis [Jankowiak, 2010, p. 6-10].

The number of physicians was previously applied as one of the indicators describing health care in published research with use of the synthetic variable regarding human living conditions in Poland [Zeliaś, 2000, p. 136]. First three of the simple indicators mentioned above have theoretically justified potential possibility of reflecting general coordination processes, occurring in regulatory and infrastructure area of health care, which results from their good dependence on administrative decisions in this field.

It was desirable to include in the set of aggregating features the one, which level is correlated with the state of health of the society. One of the indicators fulfilling this condition is infant mortality rate. In literature it is perceived as one of the best simple indicators reflecting the quality of health care system [Gasińska, 2003, p. 211]. Its additional advantage is the short time of reaction to institutional changes in health care.

The years 2003 - 2008 were accepted as the research period, which allowed dynamic assessment of the phenomenon in time series. Data from the previous years was not available, in case of public health care expenditures as percentage (%) of the GDP (it was connected with implementation of the System of Health Accounts (SHA) by Eurostat in 2003). Data from the years following 2008 was very incomplete, which would disable dynamic comparative analysis in time series[3]. Single membership country was established as a research unit. Full completeness of data in research period war required, which enabled to include in the analysis 15 countries of the European Union: Belgium, Denmark, Germany, Spain, Austria, Finland, Sweden, Bulgaria, Czech Republic, Estonia, Cyprus, Hungary, Poland, Romania and Slovenia. For the remaining countries of the European Union the data was incomplete, which made it impossible to include them in the research. The countries were divided into three groups:

- group of the „old" countries of the European Union (EU-15) including: Belgium, Denmark, Germany, Spain, Austria, Finland and Sweden;

[3] Attention is drawn to the change in value of some statistical indicators published by Eurostat (indicator of public expenses on healthcare, indicator of the number of doctors, indicator of the number of hospital beds and infant mortality rate), done for some countries in the EU in 2011 in regard to the previous years.

- group of the „new" countries which joined the European Union in 2004 and 2007 (EU-12) including: Bulgaria, Czech Republic, Estonia, Cyprus, Hungary, Poland, Romania and Slovenia;
- group of all countries subject to research (EU-27): Belgium, Denmark, Germany, Spain, Austria, Finland, Sweden, Bulgaria, Czech Republic, Estonia, Cyprus, Hungary, Poland, Romania and Slovenia.

Raw values of diagnostic indicators have been presented in the Table 1.

Table 1. Raw diagnostic indicators, used in the research

Country	2003	2004	2005	2006	2007	2008
Public health care expenditures as percentage (%) of the GDP						
Belgium	7,50	7,72	7,64	7,09	7,10	7,55
Denmark	7,42	7,48	7,53	7,68	8,01	8,27
Germany	8,22	7,86	7,95	7,84	7,76	7,92
Spain	5,53	5,57	5,62	5,70	5,81	6,25
Austria	7,48	7,57	7,58	7,52	7,53	7,70
Finland	5,77	5,87	6,05	5,89	5,65	5,87
Sweden	7,33	7,13	7,09	7,01	6,97	7,18
Bulgaria	4,65	4,37	4,53	3,97	3,88	3,86
Czech Republic	6,39	6,17	6,06	5,83	5,53	5,70
Estonia	3,81	3,85	3,82	3,63	3,92	4,59
Cyprus	2,73	2,46	2,47	2,59	2,39	2,46
Hungary	5,82	5,54	5,80	5,65	5,05	4,97
Poland	4,14	4,01	4,02	4,05	4,25	4,72
Romania	4,41	4,03	4,41	4,01	4,21	4,29
Slovenia	5,87	5,8	5,81	5,66	5,30	5,73
Practising physicians per 100 000 inhabitants						
Belgium	285,2	286,2	286,2	287,6	289,4	290,9
Denmark	307,7	321,6	330,4	337,9	339,3	341,6
Germany	336,7	339,1	341,2	345,5	350,5	356,2
Spain	328,3	340,1	379,9	365,4	368,8	352,2
Austria	410,3	418,6	430,3	444,2	452,5	458,5
Finland	256,7	259,5	263,9	268,7	269,5	272,7
Sweden	335,0	342,7	349,6	358,2	364,7	371,5
Bulgaria	360,6	353,3	365,3	366,1	365,3	361,3
Czech Republic	352,2	351,3	354,9	355,7	354,6	352,7
Estonia	316,6	321,7	316,9	319,3	325,9	333,4
Cyprus	257,3	262,3	257,8	250,4	271,5	285,6
Hungary	325,1	334,0	278,4	303,7	280,6	309,3
Poland	243,5	229,1	213,9	218,0	219,1	216,1
Romania	199,6	208,1	217,4	215,8	212,3	221,5
Slovenia	224,7	229,7	234,2	235,8	239,5	238,8
Hospital beds per 100 000 inhabitants						
Belgium	752,3	749,1	744,8	672,7	665,7	660,1
Denmark	413,9	397,6	386,3	379,8	370,1	358,2

Germany	874,4	857,6	846,4	829,1	823,4	820,3
Spain	347,8	344,5	338,9	334,2	330,2	324,5
Austria	771,3	770,7	766,2	764,9	773,1	766,2
Finland	725,3	710,9	706,5	699,9	674,5	653,8
Sweden	305,7	301,8	293,8	289,8	287,4	281,6
Bulgaria	630,3	614,7	642,9	621,4	638,1	650,8
Czech Republic	771,9	763,2	754,2	741,2	727,3	715,8
Estonia	593,4	582,6	548,4	565,3	557,3	571,5
Cyprus	431,1	421,0	380,0	373,7	374,5	377,2
Hungary	784,5	783,5	786,2	792,1	719,3	711,0
Poland	668,1	667,0	652,2	647,5	642,5	661,8
Romania	675,3	674,5	678,1	674,8	654,4	657,4
Slovenia	496,0	480,1	483,9	477,5	468,3	476,9
Infant mortality rate						
Belgium	4,1	3,9	3,7	4,0	3,9	3,7
Denmark	4,4	4,4	4,4	3,5	4,0	4,0
Germany	4,2	4,1	3,9	3,8	3,9	3,5
Spain	3,9	4,0	3,8	3,5	3,5	3,3
Austria	4,5	4,5	4,2	3,6	3,7	3,7
Finland	3,1	3,3	3,0	2,8	2,7	2,6
Sweden	3,1	3,1	2,4	2,8	2,5	2,5
Bulgaria	12,3	11,6	10,4	9,7	9,2	8,6
Czech Republic	3,9	3,7	3,4	3,3	3,1	2,8
Estonia	7,0	6,4	5,4	4,4	5,0	5,0
Cyprus	4,1	3,5	4,6	3,1	3,7	3,5
Hungary	7,3	6,6	6,2	5,7	5,9	5,6
Poland	7,0	6,8	6,4	6,0	6,0	5,6
Romania	16,7	16,8	15,0	13,9	12,0	11,0
Slovenia	4,0	3,7	4,1	3,4	2,8	2,4

Source: Eurostat.

Because the values of infant mortality rate depend in the reverse way on the efficiency of health care (the lower value of the indicator, the better state of health of the society, so low values of the indicator are desired), this variable should be recognized as de-stimulant. It was necessary to transform its values, which was conducted according to the formula:

$$sx_i = 2x_{śr} - x_i$$

where: sx_i – transformed value of feature X_i

$x_{śr}$ – arithmetic mean of feature X_i in period t

x_i - raw value of feature X_i

Values of transformed infant mortality rate, separately for each group of countries, have been presented in the Table 2.

Table 2. Values of transformed infant mortality rate

Country	2003	2004	2005	2006	2007	2008
Transformed infant mortality rate (EU-15)						
Belgium	3,7	3,9	3,6	2,9	3,0	3,0
Denmark	3,4	3,4	2,9	3,4	2,9	2,7
Germany	3,6	3,7	3,4	3,1	3,0	3,2
Spain	3,9	3,8	3,5	3,4	3,4	3,4
Austria	3,3	3,3	3,1	3,3	3,2	3,0
Finland	4,7	4,5	4,3	4,1	4,2	4,1
Sweden	4,7	4,7	4,9	4,1	4,4	4,2
Transformed infant mortality rate (EU-12)						
Bulgaria	3,3	3,2	3,5	2,7	2,7	2,5
Czech Republic	11,7	11,1	10,5	9,1	8,8	8,3
Estonia	8,6	8,4	8,5	8,0	6,9	6,1
Cyprus	11,5	11,3	9,3	9,3	8,2	7,6
Hungary	8,3	8,2	7,7	6,7	6,0	5,5
Poland	8,6	8,0	7,5	6,4	5,9	5,5
Romania	-1,1	-2,0	-1,1	-1,5	-0,1	0,1
Slovenia	11,6	11,1	9,8	9,0	9,1	8,7
Transformed infant mortality rate (EU-27)						
Belgium	7,8	7,6	7,1	5,8	5,7	5,3
Denmark	7,5	7,1	6,4	6,3	5,6	5,0
Germany	7,7	7,4	6,9	6,0	5,7	5,5
Spain	8,0	7,5	7,0	6,3	6,1	5,7
Austria	7,4	7,0	6,6	6,2	5,9	5,3
Finland	8,8	8,2	7,8	7,0	6,9	6,4
Sweden	8,8	8,4	8,4	7,0	7,1	6,5
Bulgaria	-0,4	-0,1	0,4	0,1	0,4	0,4
Czech Republic	8,0	7,8	7,4	6,5	6,5	6,2
Estonia	4,9	5,1	5,4	5,4	4,6	4,0
Cyprus	7,8	8,0	6,2	6,7	5,9	5,5
Hungary	4,6	4,9	4,6	4,1	3,7	3,4
Poland	4,9	4,7	4,4	3,8	3,6	3,4
Romania	-4,8	-5,3	-4,2	-4,1	-2,4	-2,0
Slovenia	7,9	7,8	6,7	6,4	6,8	6,6

Source: Author's study based on the Eurostat data.

After adequate transformations normalized value of infant mortality rate could be included in the set of features subject to aggregation. In order to perform aggregation of diagnostic indicators in one synthetic measure it was necessary to normalize their values. In literature there are many methods of variable normalization [Grabiński, Wydmus, Zeliaś, 1989, p. 118-119; Kolenda, 2006, p.41-47; Zeliaś, 2000, p.56-74]. They are described with the general formula:

$x_i' = ((x_i - A) / B)^p$ for i = 1,2,3,...,n where: x_i' – normalized values of the i variant of feature X,

x_i – value before normalization of the i variant of feature X,

n – number of observations of feature X,

A, B, p – equation parameters.

The aim of normalization is to enable mutual comparison between diagnostic features. Depending on values of the equation parameters different forms of normalization formula are achieved. These differences reveal in, among others, different influence of normalization on relations between descriptive statistics of real and normalized variables, especially on values of measures of diversity (e.g. standard deviation). Depending on normalization methods, mutual relations between values of diversity measures for successive sets of diagnostic variables can be retained or distorted. Because in the paper dynamics of the synthetic indicator diversity is assessed, normalization method was applied, maintaining in successive years in time series, the same proportions of standard deviation for real variables and for normalized variables.

Normalization of diagnostic variables with reference to constant pattern, according to the mentioned bellow formula has been applied:

$$x_i' = x_i / x_0 \quad (n=1,2,...,n)$$

where: x_0 – constant point of reference (pattern),

the rest of the symbols as previously.

As the constant point of reference (x_0) was adopted the arithmetic mean of feature X in the first research period [Zeliaś, 2000, p.137]. Used method of normalization maintained the same relations of standard deviation in consecutive research periods for normalized variables, that existed previously for raw variables, which enables the analysis of changes in dynamics of diversification of the synthetic variable.

Similar method of normalization has been applied by A. Zeliaś in the study of human living conditions, where, among others, the dynamic of diversification of the synthetic variable in successive periods, measured with use of standard deviation, has been analyzed [Zeliaś, 2000, p.134-144]. Configuration of values of normalized variables in the consecutive years is presented: for the "old" countries of the

European Union (EU-15) in the Table 3a, for the "new" countries of the European Union (EU-12) in the Table 3b and for all analyzed countries (EU-27) in the Table 3c.

Table 3.a. Normalized values of diagnostic indicators for the „old" countries of the European Union (EU-15)

Country	2003	2004	2005	2006	2007	2008
Public health care expenditurs as percentage (%) of the GDP						
Belgium	1,0660	1,0973	1,0859	1,0077	1,0091	1,0731
Denmark	1,0546	1,0631	1,0703	1,0916	1,1385	1,1754
Germany	1,1683	1,1172	1,1299	1,1143	1,1029	1,1257
Spain	0,7860	0,7917	0,7988	0,8102	0,8258	0,8883
Austria	1,0631	1,0759	1,0774	1,0688	1,0703	1,0944
Finland	0,8201	0,8343	0,8599	0,8372	0,8030	0,8343
Sweden	1,0418	1,0134	1,0077	0,9963	0,9907	1,0205
Practising physicians per 100 000 inhabitants						
Belgium	0,8834	0,8865	0,8865	0,8908	0,8964	0,9011
Denmark	0,9531	0,9962	1,0234	1,0466	1,0510	1,0581
Germany	1,0429	1,0504	1,0569	1,0702	1,0857	1,1033
Spain	1,0169	1,0535	1,1767	1,1318	1,1424	1,0909
Austria	1,2709	1,2966	1,3328	1,3759	1,4016	1,4202
Finland	0,7951	0,8038	0,8174	0,8323	0,8348	0,8447
Sweden	1,0377	1,0615	1,0829	1,1095	1,1297	1,1507
Hospital beds for 100 000 inhabitants						
Belgium	1,2566	1,2513	1,2441	1,1237	1,1120	1,1026
Denmark	0,6914	0,6641	0,6453	0,6344	0,6182	0,5983
Germany	1,4606	1,4325	1,4138	1,3849	1,3754	1,3702
Spain	0,5810	0,5754	0,5661	0,5582	0,5516	0,5420
Austria	1,2884	1,2874	1,2798	1,2777	1,2914	1,2798
Finland	1,2115	1,1875	1,1801	1,1691	1,1267	1,0921
Sweden	0,5106	0,5041	0,4908	0,4841	0,4801	0,4704
Infant mortality rate						
Belgium	0,9487	1,0000	0,9121	0,7326	0,7729	0,7582
Denmark	0,8718	0,8718	0,7326	0,8608	0,7473	0,6813
Germany	0,9231	0,9487	0,8608	0,7839	0,7729	0,8095
Spain	1,0000	0,9744	0,8864	0,8608	0,8755	0,8608
Austria	0,8462	0,8462	0,7839	0,8352	0,8242	0,7582
Finland	1,2051	1,1538	1,0916	1,0403	1,0806	1,0403
Sweden	1,2051	1,2051	1,2454	1,0403	1,1319	1,0659

Source: Author's study based on the Eurostat data.

Table 3.b. Normalized values of diagnostic indicators for the „new" countries of the European Union (EU-12).

Country	2003	2004	2005	2006	2007	2008
Public health care expenditures as percentage (%) of the GDP						
Bulgaria	0,9836	0,9244	0,9582	0,8398	0,8207	0,8165
Czech Republic	1,3517	1,3051	1,2819	1,2332	1,1698	1,2057
Estonia	0,8059	0,8144	0,8080	0,7678	0,8292	0,9709
Cyprus	0,5775	0,5204	0,5225	0,5479	0,5056	0,5204
Hungary	1,2311	1,1719	1,2269	1,1951	1,0682	1,0513
Poland	0,8757	0,8482	0,8503	0,8567	0,8990	0,9984
Romania	0,9328	0,8525	0,9328	0,8482	0,8905	0,9075
Slovenia	1,2417	1,2269	1,2290	1,1973	1,1211	1,2121
Practising physicians per 100 000 inhabitants						
Bulgaria	1,2655	1,2399	1,2820	1,2848	1,2820	1,2679
Czech Republic	1,2360	1,2328	1,2455	1,2483	1,2444	1,2378
Estonia	1,1111	1,1290	1,1121	1,1205	1,1437	1,1700
Cyprus	0,9030	0,9205	0,9047	0,8788	0,9528	1,0023
Hungary	1,1409	1,1721	0,9770	1,0658	0,9847	1,0855
Poland	0,8545	0,8040	0,7507	0,7650	0,7689	0,7584
Romania	0,7005	0,7303	0,7629	0,7573	0,7450	0,7773
Slovenia	0,7886	0,8061	0,8219	0,8275	0,8405	0,8380
Hospital beds for 100 000 inhabitants						
Bulgaria	0,9984	0,9737	1,0183	0,9843	1,0107	1,0308
Czech Republic	1,2227	1,2089	1,1946	1,1740	1,1520	1,1338
Estonia	0,9399	0,9228	0,8686	0,8954	0,8827	0,9052
Cyprus	0,6828	0,6669	0,6019	0,5919	0,5932	0,5975
Hungary	1,2426	1,2410	1,2453	1,2547	1,1393	1,1262
Poland	1,0583	1,0565	1,0331	1,0256	1,0177	1,0483
Romania	1,0697	1,0684	1,0741	1,0689	1,0366	1,0413
Slovenia	0,7856	0,7605	0,7665	0,7563	0,7418	0,7554
Infant mortality rate						
Bulgaria	0,4205	0,4077	0,4462	0,3435	0,3499	0,3242
Czech Republic	1,4992	1,4222	1,3451	1,1653	1,1332	1,0690
Estonia	1,1011	1,0754	1,0883	1,0241	0,8892	0,7865
Cyprus	1,4735	1,4478	1,1910	1,1910	1,0562	0,9791
Hungary	1,0626	1,0498	0,9856	0,8571	0,7737	0,7095
Poland	1,1011	1,0241	0,9599	0,8186	0,7608	0,7095
Romania	-0,1445	-0,2600	-0,1445	-0,1958	-0,0096	0,0161
Slovenia	1,4864	1,4222	1,2552	1,1525	1,1717	1,1204

Source: Author's study based on the Eurostat data.

Table 3.c. Normalized values of diagnostic indicators for all analyzed countries of the European Union (EU-27).

Country	2003	2004	2005	2006	2007	2008
Public health care expenditures as percentage (%) of the GDP						
Belgium	1,2921	1,3300	1,3162	1,2214	1,2232	1,3007
Denmark	1,2783	1,2886	1,2972	1,3231	1,3799	1,4247
Germany	1,4161	1,3541	1,3696	1,3506	1,3369	1,3644
Spain	0,9527	0,9596	0,9682	0,9820	1,0009	1,0767
Austria	1,2886	1,3041	1,3058	1,2955	1,2972	1,3265
Finland	0,9940	1,0113	1,0423	1,0147	0,9734	1,0113
Sweden	1,2628	1,2283	1,2214	1,2076	1,2008	1,2369
Bulgaria	0,8011	0,7528	0,7804	0,6839	0,6684	0,6650
Czech Republic	1,1008	1,0629	1,0440	1,0044	0,9527	0,9820
Estonia	0,6564	0,6633	0,6581	0,6254	0,6753	0,7907
Cyprus	0,4703	0,4238	0,4255	0,4462	0,4117	0,4238
Hungary	1,0026	0,9544	0,9992	0,9734	0,8700	0,8562
Poland	0,7132	0,6908	0,6925	0,6977	0,7322	0,8131
Romania	0,7597	0,6943	0,7597	0,6908	0,7253	0,7391
Slovenia	1,0113	0,9992	1,0009	0,9751	0,9131	0,9871
Practising physicians per 100 000 inhabitants						
Belgium	0,9424	0,9457	0,9457	0,9503	0,9563	0,9612
Denmark	1,0167	1,0627	1,0918	1,1165	1,1212	1,1288
Germany	1,1126	1,1205	1,1274	1,1416	1,1582	1,1770
Spain	1,0848	1,1238	1,2553	1,2074	1,2186	1,1638
Austria	1,3558	1,3832	1,4219	1,4678	1,4952	1,5150
Finland	0,8482	0,8575	0,8720	0,8879	0,8905	0,9011
Sweden	1,1070	1,1324	1,1552	1,1836	1,2051	1,2276
Bulgaria	1,1915	1,1674	1,2071	1,2097	1,2071	1,1939
Czech Republic	1,1638	1,1608	1,1727	1,1753	1,1717	1,1654
Estonia	1,0462	1,0630	1,0471	1,0551	1,0769	1,1017
Cyprus	0,8502	0,8667	0,8519	0,8274	0,8971	0,9437
Hungary	1,0742	1,1036	0,9199	1,0035	0,9272	1,0220
Poland	0,8046	0,7570	0,7068	0,7203	0,7240	0,7141
Romania	0,6595	0,6876	0,7184	0,7131	0,7015	0,7319
Slovenia	0,7425	0,7590	0,7739	0,7792	0,7914	0,7891
Hospital beds per 100 000 inhabitants						
Belgium	1,2211	1,2159	1,2089	1,0919	1,0805	1,0714
Denmark	0,6718	0,6454	0,6270	0,6165	0,6007	0,5814
Germany	1,4193	1,3920	1,3738	1,3458	1,3365	1,3315
Spain	0,5645	0,5592	0,5501	0,5425	0,5360	0,5267
Austria	1,2519	1,2510	1,2437	1,2415	1,2549	1,2437
Finland	1,1773	1,1539	1,1468	1,1360	1,0948	1,0612
Sweden	0,4962	0,4899	0,4769	0,4704	0,4665	0,4571
Bulgaria	1,0231	0,9977	1,0435	1,0086	1,0357	1,0563
Czech Republic	1,2529	1,2388	1,2242	1,2031	1,1805	1,1618
Estonia	0,9632	0,9456	0,8901	0,9176	0,9046	0,9276
Cyprus	0,6997	0,6833	0,6168	0,6066	0,6079	0,6123
Hungary	1,2734	1,2717	1,2761	1,2857	1,1675	1,1541

Poland	1,0844	1,0826	1,0586	1,0510	1,0429	1,0742
Romania	1,0961	1,0948	1,1007	1,0953	1,0622	1,0671
Slovenia	0,8051	0,7793	0,7854	0,7751	0,7601	0,7741
Infant mortality rate						
Belgium	1,3136	1,2757	1,1864	0,9710	0,9520	0,8940
Denmark	1,2634	1,1920	1,0692	1,0547	0,9353	0,8438
Germany	1,2969	1,2422	1,1529	1,0045	0,9520	0,9275
Spain	1,3471	1,2589	1,1696	1,0547	1,0190	0,9609
Austria	1,2467	1,1752	1,1027	1,0379	0,9855	0,8940
Finland	1,4810	1,3761	1,3036	1,1719	1,1529	1,0781
Sweden	1,4810	1,4096	1,4040	1,1719	1,1864	1,0949
Bulgaria	-0,0592	-0,0134	0,0647	0,0167	0,0647	0,0737
Czech Republic	1,3471	1,3092	1,2366	1,0882	1,0859	1,0446
Estonia	0,8281	0,8571	0,9018	0,9040	0,7679	0,6763
Cyprus	1,3136	1,3426	1,0357	1,1217	0,9855	0,9275
Hungary	0,7779	0,8237	0,7679	0,6864	0,6172	0,5759
Poland	0,8281	0,7902	0,7344	0,6362	0,6004	0,5759
Romania	-0,7958	-0,8839	-0,7054	-0,6864	-0,4040	-0,3281
Slovenia	1,3304	1,3092	1,1194	1,0714	1,1362	1,1116

Source: Author's study based on the Eurostat data.

Next stage in constructing the synthetic indicator was weighting of normalized values of diagnostic features. System of weights reflects the meaning of particular features and their participation in forming values of the synthetic indicator. The meaning of the diagnostic variables and the way of establishing weights for the particular variable may be determined by content-related reasons – resulting from the aim of research and established with use of the expert method or other reasons, which are not content-related – based on statistic characteristics of the particular variable, e.g. variance of variable's values. In empirical studies the system of constant (equal) weights is often applied [Grabiński, Wydmus, Zeliaś, 1989, p. 25-27; Kolenda, 2006, p.44-48]. It signifies that all diagnostic variables have identical meaning for building the synthetic indicator.

One of the methods of determining constant weights is given by the formula:

$w_i = 1 / n$

where: w_i – weight for i diagnostic variable,

n – total number of diagnostic variables.

Weights calculated in this way sum up to one and value of single weight amounts to (for four diagnostic variables in present research, n = 4):

$w_i = 1/4 = 0,25$ and $\Sigma w_i = 1$

After normalization of the diagnostic variables, based on accepted system of weights, it is possible to aggregate those variables in one single synthetic indicator. Among many different methods of aggregation, attention should be paid to additive model, in which synthetic indicator originates from weighted addition of diagnostic variables. In the paper has been accepted the following aggregation method, in which normalized diagnostic variables are measured with the system of constant weights, summing up to one, and afterwards connected according to the formula [Kolenda 2006, p.135-136]:

$z_t = \Sigma x_{it}' \cdot w_{i;}$ dla $\Sigma w_i = 1$

where: z_t – value of synthetic indicator in period t,
x_{it}' – normalized value of i diagnostic variable in period t,
w_i – weight for i variable (here 0,25).

This method arranges the research objects (membership countries), allowing to evaluate their diversity, measured by standard deviation of the synthetic variable[4]. The value of the synthetic indicator in the consecutive years of research period was presented in the Table 4.a. for the „old" membership countries (EU-15), in the Table 4.b. for the "new" membership countries (EU-12) and in the Table 4.c. for the countries of the widened European Union (EU-27).

Table 4.a. Values and diversity of synthetic indicator for the group EU-15

Country	2003	2004	2005	2006	2007	2008
Belgium	1,0387	1,0588	1,0321	0,9387	0,9476	0,9588
Denmark	0,8927	0,8988	0,8679	0,9084	0,8887	0,8783
Germany	1,1487	1,1372	1,1154	1,0883	1,0842	1,1022
Spain	0,8460	0,8487	0,8570	0,8403	0,8488	0,8455
Austria	1,1171	1,1265	1,1185	1,1394	1,1468	1,1382
Finland	1,0080	0,9949	0,9873	0,9697	0,9613	0,9528
Sweden	0,9488	0,9460	0,9567	0,9076	0,9331	0,9269
arithmetic mean	1,0000	1,0016	0,9907	0,9703	0,9729	0,9718
standard devaition	0,1120	0,1113	0,1062	0,1066	0,1061	0,1095

Source: Author's study based on the Eurostat data.

[4] Conclusions regarding diversity of the synthetic variable based on its standard deviation and variation factor were drawn, in order to study human living conditions, among others, by A.Zeliaś [2000, p.134-144].

Table 4.b. Values and diversity of synthetic indicator for the group EU-12

Country	2003	2004	2005	2006	2007	2008
Bulgaria	0,9170	0,8864	0,9262	0,8631	0,8658	0,8599
Czech Republic	1,3274	1,2923	1,2668	1,2052	1,1749	1,1616
Estonia	0,9895	0,9854	0,9693	0,9520	0,9362	0,9582
Cyprus	0,9092	0,8889	0,8050	0,8024	0,7769	0,7748
Hungary	1,1693	1,1587	1,1087	1,0932	0,9915	0,9931
Poland	0,9724	0,9332	0,8985	0,8665	0,8616	0,8786
Romania	0,6396	0,5978	0,6564	0,6196	0,6656	0,6855
Slovenia	1,0756	1,0539	1,0181	0,9834	0,9688	0,9815
arithmetic mean	1,0000	0,9746	0,9561	0,9232	0,9052	0,9116
standard deviation	0,2026	0,2070	0,1854	0,1799	0,1523	0,1463

Source: Author's study based on the Eurostat data.

Table 4.c. Values and diversity of synthetic indicator for the group EU-27

Country	2003	2004	2005	2006	2007	2008
Belgium	1,1923	1,1918	1,1643	1,0587	1,0530	1,0568
Denmark	1,0576	1,0472	1,0213	1,0277	1,0093	0,9947
Germany	1,3112	1,2772	1,2559	1,2106	1,1959	1,2001
Spain	0,9873	0,9754	0,9858	0,9466	0,9436	0,9320
Austria	1,2857	1,2784	1,2685	1,2607	1,2582	1,2448
Finland	1,1251	1,0997	1,0912	1,0526	1,0279	1,0129
Sweden	1,0867	1,0650	1,0644	1,0084	1,0147	1,0041
Bulgaria	0,7391	0,7262	0,7739	0,7298	0,7440	0,7472
Czech Republic	1,2162	1,1929	1,1694	1,1177	1,0977	1,0885
Estonia	0,8735	0,8823	0,8743	0,8755	0,8562	0,8741
Cyprus	0,8335	0,8291	0,7325	0,7505	0,7256	0,7268
Hungary	1,0320	1,0384	0,9908	0,9872	0,8955	0,9020
Poland	0,8576	0,8302	0,7981	0,7763	0,7749	0,7943
Romania	0,4299	0,3982	0,4683	0,4532	0,5212	0,5525
Slovenia	0,9723	0,9617	0,9199	0,9002	0,9002	0,9155
arithmetic mean	1,0000	0,9862	0,9719	0,9437	0,9345	0,9364
standard deviation	0,2311	0,2321	0,2176	0,2068	0,1927	0,1830

Source: Author's study based on the Eurostat data.

3. Results

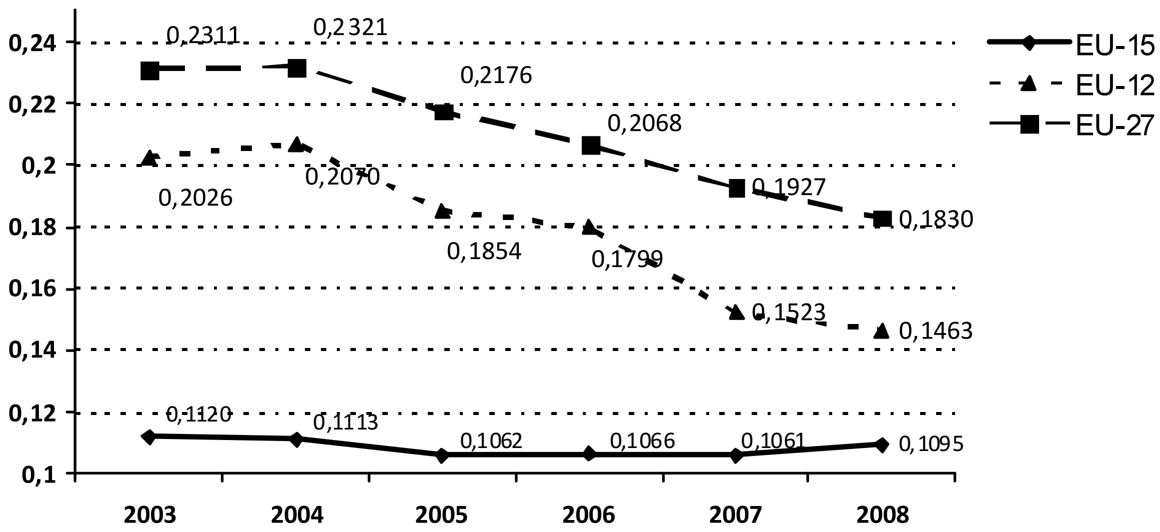
In the Table 5 and on the Chart 1 were presented collectively for particular groups of countries the values of standard deviation of the synthetic indicator in the research period (2003 - 2008).

Table 5. Values of standard deviation of the synthetic indicator in the research period (2003-2008) for particular groups of countries.

Group of EU countries	*Standard deviation of synthetic indicator*					
	2003	2004	2005	2006	2007	2008
EU-15	0,1120	0,1113	0,1062	0,1066	0,1061	0,1095
EU-12	0,2026	0,2070	0,1854	0,1799	0,1523	0,1463
EU-27	0,2311	0,2321	0,2176	0,2068	0,1927	0,1830

Source: Author's study based on the Eurostat data.

Chart 1. Changes in standard deviation of the synthetic indicator in the research period (2003-2008).



Source: Author's study based on the Eurostat data.

In the group of the "old" countries of the European Union (EU-15) attention is drawn to the primarily low and in the research period still slightly decreasing standard deviation of the values of the synthetic indicator: beginning from 0,1120 in 2003 and finishing with 0,1095 in 2008, with minimum 0,1061 in 2007. This formation of diversity of the synthetic indicator (high initial convergence with weakly growing tendency in the successive years) may indicate good at the starting point and increasing in time convergence of health care systems in the estimated group of countries.

In the analysis conducted for the group of newly accepted countries of the European Union (EU-12) the decreasing trend in standard deviation of the values of the synthetic indicator is present, however its values in the consecutive years remain not that low, as the ones for the countries of EU-15. Standard deviation decreased from 0,2026 to 0,1463, which indicates substantially growing level of synthetic indicator convergence in the research period. It may show fast progressing (faster than in the group EU-15) convergence of health care systems in the group EU-12.

Growth dynamics of the synthetic indicator convergence in the group of „new" countries of the European Union is bigger than among the „old" countries, which caused that the difference in values of standard deviation of the synthetic indicator between the group EU-15 and the group EU-12 was significantly smaller by the end of the research period, than at its beginning. It is confirmed by the analysis of diversity of the synthetic indicator in the group of all researched countries of the European Union (EU-27), which in the considered period indicates significant decrease in standard deviation from 0,2311 to 0,1830. It results from, among others, similar direction of changes of synthetic indicator values, both in the group of the „old" and the „new" countries and from the bigger dynamics of changes among the „new" countries. It leads to the emergence of convergence of the synthetic indicator between both groups of countries, beside convergence inside each of these groups, claimed in the previous analysis.

It may indicate that certain convergence processes in the field of health care occur in the scale of the entire European Union, which are based on faster imitation of the "old" membership countries (EU-15) by the "new" membership countries (EU-12), in comparison to the slower rate in decrease of diversity inside the group EU-15. In its mechanism the phenomenon is similar to convergence of GDP, stated by R.J. Barro and X. Sala-i-Martin among countries with different level of GDP, where the countries with lower GDP increase its value faster than the countries with higher GDP [Barro, Sala-i-Martin, 1995].

General direction of changes in dispersion of synthetic indicator, claimed for the countries of the entire European Union is decreasing. In the first place it results from visible convergence trends for the group of more diversified countries (that is the group of the new European Union members). As it was mentioned above, in the research period, standard deviation of synthetic indicator in the group EU-27 decreased from 0,2311 to 0,1830, which allows the confirmation of the thesis of growing in time convergence of health care in the scale of the entire European Union, at least in the range described with use of the synthetic indicator.

5. Summary

Methods of numeric taxonomy used to aggregate many simple statistic indicators have been applied in order to obtain one single synthetic indicator, reflecting the whole convergence processes of health care systems in the countries of the European Union. Chosen simple features, which were the part of the aggregate, allowed the joint evaluation of convergence from different perspectives: both from the widely understood health care infrastructure (financial and substantial) and from the influence of medical care on the real state of health of the society.

Basing on the analysis of the synthetic indicator diversity it has been possible to distinguish growing convergence in the group of the "old" countries of the European Union as well as in the newly accepted countries. Convergence processes have been most significantly visible in the group of the newly accepted countries.

Apart from the convergence inside each of the groups of countries, it could be stated, that convergence between both groups of countries is growing, which reflects convergence phenomena of health care in scale of the entire European Union. This convergence had two reasons: first of all similar direction of changes in diversity in both groups of countries and second of all faster decrease in diversity among the newly accepted countries.

Proposed aggregate indicator, based on the synthetic variable, enables episodic or periodic evaluation of achieved convergence degree between countries in the European Union in the field of health care. Because it is based on indicators published by Eurostat, its calculation is relatively simple and does not require gathering additional statistical data. With regard to its quite simple construction, it may find use in current monitoring of efficiency in open coordination of health care.

Advisable would be improvement of quality of initial statistical data delivered by Eurostat by increasing geographical and chronological availability of data (to this time there is lack of some simple statistical indicators for many membership countries and there is too big delay in publishing data). However not only Eurostat is responsible for reduced quality of statistical data, but also national statistical offices of some countries in the European Union. In the analyzed field the cooperation between Central Statistical Office of Poland and Eurostat was very good.

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