ISSN 2392-1641
e-ISSN 2450-0097

Economics and Business Review

Volume 7 (21) Number 2 2021

CONTENTS

Poznań University of Economics and Business Press

Paper based publication

ISSN 2392-1641
e-ISSN 2450-0097

POZNAŃ UNIVERSITY OF ECONOMICS AND BUSINESS PRESS
ul. Powstańców Wielkopolskich 16, 61-895 Poznań, Poland
phone +48 61 854 31 54, +48 61 854 31 55
www.wydawnictwo.ue.poznan.pl, e-mail: wydawnictwo@ue.poznan.pl
postal address: al. Niepodległości 10, 61-875 Poznań, Poland

Printed and bound in Poland by:
Poznań University of Economics and Business Print Shop

Circulation: 215 copies

sciendo

Economics and Business Review, Vol. 7 (21), No. 2, 2021: 37-49
DOI: 10.18559/ebr.2021.2.4

The EU Member States' national healthcare systems compared using the single synthetic index[1]

Maciej Jankowiak[2]

Abstract: Implementation of health protection requires effective quantitative methods of its evaluation. Assessment could be based on usage of synthetic indices which aggregate couple input variables into a single measure. In this paper, the exploitation of a new synthetic index (by the author called HAI—the Healthcare Aggregated Index) was proposed with the aim of the assessment and long-term interstate comparisons of healthcare systems of the EU countries. Using taxonomic methodology, HAI involves three variables: the number of hospital beds, the number of physicians and the public expenditures on healthcare. HAI utilisation includes dynamic interstate comparisons of national healthcare systems of the different exploitations of human, physical and financial resources. The HAI application to assessment of twenty European Union Member States' healthcare systems revealed an effect of substitution between healthcare resources within the slight international differentiation of the health protection level and the minor dynamic of changes in time series.

Keywords: comparisons of healthcare; healthcare systems in EU, quantitative assessment of healthcare, aggregated index of healthcare, HAI index, numerical taxonomy.

JEL codes: I14, I18, C55.

Introduction

International quantitative and comparative studies have been becoming an important part of area of international economics and entrepreneurship research (Głodowska, 2019; Manera, Navinés, & Franconneti, 2017; Pera, 2016). In the same way evaluation of healthcare systems plays an increasing role in the field of health protection and healthcare management. Especially the assessment based on quantitative methods of data analysis is useful for planning and managing healthcare and for international comparisons of healthcare sys-

[1] Article received 19 December 2020, accepted 25 June 2021.

[2] Poznań University of Medical Sciences, Department of Organisation and Healthcare Management, ul. Przybyszewskiego 39, 60-356 Poznań, Poland, mjankowiak@ump.edu.pl, ORCID: 0000-0002-1803-2364.

tems (Schenkman & Bousquat, 2021). There are lots of simple indicators quantitatively describing narrow aspects of healthcare (Zahid, Poulsen, Sharma, & Wingreen, 2021; van Biesen et al., 2021; Mousa, 2018). Simple indicators could cover the area of health infrastructure (such as the number of hospital beds, number of medical professionals), financing of healthcare (such as expenditures on healthcare) or health status of population (such as life expectancy, mortality rates, incidence of some diseases). Nevertheless the real challenge is to propose a practical tool for the assessment of this simple indicators multiplicity (Gerrits, Kringos, van den Berg, & Klazinga, 2018). The solution could be a single aggregated index which enables the inclusion of a wide range of information originating from a variety of simple indicators in one grouping. Synthetic indexes based on the methodology of the numerical taxonomy could be used in order to obtain an aggregated information from different sources among others (Leuschner, 1991; Rothenberg et al., 2015; Fagigh & Sazegar, 2019). Synthetic indexes might be employed in international comparisons of healthcare systems as well (Jankowiak, 2011).

In this paper, a new kind of a synthetic index (named by the author HAI—the Healthcare Aggregated Index) is used in order to fulfil the aim of the research: the quantitative longitudinal assessment and comparison of infrastructure and financing of national healthcare systems of European Union countries. In Section 1 data derived from Eurostat and OECD databases are presented and the exact methodology of HAI calculation is described. HAI values in time series for each of the twenty EU Member States included in the research are given in Section 2. This section provides graphical representation of HAI dynamics as well. That is a starting point for international comparisons and the analysis of differences set out in the subsequent part of the paper. Proposals of further investigations and summarizing conclusions are listed at the end of the paper.

1. Materials and methods

In this research three simple indicators of healthcare systems (treated as raw variables X_1, X_2 and X_3) are used in the construction of the synthetic index. Two of them describe the infrastructure of healthcare, these are: the number of hospital beds per 100,000 inhabitants (X_1) and the number of practising physicians per 100,000 inhabitants (X_2). The third indicator used in this research is the public healthcare expenditures (governmental and compulsory contributory health care financing schemes) as a percentage of the gross domestic product (X_3). These three indicators were arbitrarily chosen because they cover both infrastructural and financial perspectives of the healthcare supply reflecting three basic resources: physical, human and financial capital. A good international availability of these indicators was important as well. Data originated from EUROSTAT and OECD databases were obtained in September, 2020. The

Table 1. Raw values of the initial variables (indicators) used in the research

Variable	X_1—Hospital beds (per 100,000 inhabitants)[a]					X_2—Physicians (per 100,000 inhabitants)[b]					X_3—Public healthcare expenditure (%GDP)[c]				
Year	**2013**	**2014**	**2015**	**2016**	**2017**	**2013**	**2014**	**2015**	**2016**	**2017**	**2013**	**2014**	**2015**	**2016**	**2017**
Belgium	592.76	585.15	583.22	576.40	566.35	295.71	297.55	301.75	307.41	308.29	8.03	7.92	7.90	7.82	7.90
Bulgaria	681.64	712.98	723.50	726.95	745.40	397.67	398.69	404.54	413.76	424.49	4.07	4.51	4.16	4.14	4.17
Denmark	307.06	268.88	253.01	259.62	260.83	384.94	387.74	392.93	399.82	410.89	8.57	8.56	8.61	8.53	8.50
Germany	827.77	822.82	813.31	806.26	800.23	403.50	410.82	413.93	418.65	424.88	9.21	9.28	9.40	9.47	9.61
Estonia	500.53	500.55	495.97	475.84	469.49	333.46	335.88	341.49	345.65	346.82	4.52	4.60	4.80	4.92	4.87
Ireland	256.00	257.40	292.01	295.94	297.02	267.46	301.20	311.91	319.18	325.75	7.33	6.87	5.27	5.37	5.21
Spain	296.34	296.63	297.92	296.59	297.43	381.09	380.08	384.54	382.35	387.68	6.44	6.39	6.51	6.41	6.32
France	627.18	619.68	613.46	605.88	598.02	309.83	310.89	312.24	313.79	315.80	8.72	8.86	8.79	9.55	9.48
Croatia	586.04	590.62	556.30	549.25	553.97	303.35	314.02	319.15	323.65	336.21	5.54	5.56	5.61	5.64	5.60
Italy	331.17	321.09	319.55	317.21	318.07	390.01	388.04	383.83	395.27	398.95	6.65	6.69	6.59	6.49	6.40
Cyprus	340.86	341.58	341.53	342.67	339.96	319.51	337.83	359.34	376.84	386.84	3.20	3.00	2.88	2.81	2.79
Latvia	579.98	565.71	569.45	571.97	556.67	319.13	321.60	319.79	321.25	320.50	3.24	3.26	3.33	3.47	3.44
Lithuania	731.25	726.38	696.61	669.16	655.78	427.70	430.74	433.92	446.69	455.63	4.06	4.19	4.36	4.42	4.28
Luxembourg	517.15	505.29	493.33	480.58	466.18	283.05	288.14	290.73	288.45	298.49	4.59	4.54	4.42	4.34	4.41
Hungary	703.73	698.43	699.41	700.15	701.90	320.91	332.35	309.72	321.12	332.48	4.84	4.76	4.75	4.80	4.70
Austria	764.46	758.39	753.68	742.14	736.62	498.85	504.61	509.12	512.96	518.28	7.61	7.67	7.68	7.66	7.66
Poland	660.84	662.70	663.47	664.04	662.38	224.09	230.68	232.81	241.58	237.75	4.50	4.42	4.44	4.55	4.53[d]
Romania	667.31	671.15	679.12	683.99	689.21	264.36	269.83	276.58	284.10	292.68	4.12	3.97	3.86	3.91	4.05
Slovenia	455.20	453.74	451.41	448.71	449.77	262.92	277.02	282.53	301.40	310.11	6.24[d]	6.05	6.12	6.18	5.91
Sweden	259.30	253.79	243.94	233.89	221.19	404.33	410.88	417.37	423.18	426.52	9.16	9.20	9.08	9.15	9.14
Mean value	**534.33**	**530.65**	**527.01**	**522.36**	**519.32**	**339.59**	**346.43**	**349.91**	**356.86**	**362.95**	**6.03**	**6.02**	**5.93**	**5.98**	**5.95**

Notes: [a] Source: Eurostat, Hospital beds [TPS00046], access 21.09.2020; [b] Source: Eurostat, Practising physicians [TPS00044], access 21.09.2020; [c] Source: Eurostat, Health care expenditure by financing scheme - Government schemes and compulsory contributory health care financing schemes [HLTH_SHA11_HF__custom_6281], access 23.09.2020; [d] Data obtained from OECD database (https://stats.oecd.org/Index.aspx?DataSetCode=SHA), access 24.09.2020.

Source: Own work.

time series cover the period 2013–2017 as since 2018 there have been too many data gaps in time series. The research contains the European Union Member States but countries for which there was lack of complete data in the examined period were excluded which finally resulted in twenty EU Member States being considered in this research. The list of the included countries and raw values of the healthcare indicators are presented in Table 1.

The aggregated synthetic index of healthcare (named in this paper HAI—the Healthcare Aggregated Index) applied in this research was calculated with the usage of the numerical taxonomy methodology. The general formula of calculation is given below:

$$HAI_k = \Sigma(Z_{ik} \cdot w_i) \qquad \text{and} \qquad \Sigma w_i = 1 \qquad (1)$$

where:

HAI_k—value of the aggregated synthetic index of healthcare for the *k* EU Member State,

Z_{ik} —normalised value of the *i* variable for the *k* EU Member State,

w_i —weight for the *i* variable.

In this research the system of equal weights was adopted so for the three variables considered (simple indicators) the value of each w_i is ⅓ and the formula (1) takes the form:

$$HAI_k = ⅓\ \Sigma Z_{ik}, \qquad \text{for } i = 1, 2, 3 \qquad (2)$$

where:

HAI_k, Z_{ik}—symbols as above.

Variables X_1, X_2 and X_3 have been treated as “stimulants”. It means that the increasing value of each variables is related with better healthcare resources. Normalisation of “stimulants” X_1, X_2 and X_3 was calculated using the following formula:

$$Z_{ik} = X_{ik} / X_{i\,mean}, \qquad \text{for } i = 1, 2, 3 \qquad (3)$$

where:

Z_{ik} —normalised value of the *i* variable for the *k* EU Member State,

X_{ik} —raw value of the *i* variable for the *k* EU Member State:

X_{1k} —the number of hospital beds per 100,000 inhabitants in the *k* EU Member State,

X_{2k} —the number of practising physicians per 100,000 inhabitants in the *k* EU Member State,

X_{3k} —the public healthcare expenditures (governmental and compulsory contributory health care financing schemes) in percentage of gross domestic product in the *k* EU Member State,

$X_{i\ mean}$ —mean value of the *i* variable for the all included EU Member State.

Normalised values of variables Z_{1k}, Z_{2k}, Z_{3k} were used in the calculation of HAI upon formula (2).

2. Results

Normalised values of the variables (Z_1, Z_2, Z_3) are presented in Table 2. In order to assess the differentiation of normalised variables among the EU countries the standard deviation was used directly because the mean value of the each normalised variable is always 1.00. Based on the value of the standard deviation of the normalised variables the differentiation among the EU Member States of the number of hospital beds and the public expenditures on healthcare is similar and rather high (the standard deviation about 0.33—0.34). The differentiation of the number of physicians is lower (the standard deviation about 0.18—0.20) and slightly decreasing during the evaluated period. Values of the normalised variables were used in order to calculate the aggregated synthetic index of healthcare (HAI) upon the formula (2).

The values and the standard deviations of HAI in the time series are presented in Table 3. The standard deviation of HAI stands between 0.174 and 0.178, and shows a minor increasing tendency during the research period. Similarly as in case of normalised single variables the mean value of HAI is always 1.00. On the other hand the standard deviation of HAI is visibly lower than the standard deviations of each single variable used in construction of HAI that probably reflects an effect of substitution between different healthcare resources.

Setting two limits: the lower limit standing at the HAI mean value minus its standard deviation and the upper limit standing at the HAI mean value plus its standard deviation it is possible to establish three intervals of the HAI value. The first interval below the lower limit, the second between the lower and the upper limits and the third above the upper limit. Values of both limits change during subsequent years of the research, following alterations in HAI standard deviations and they are presented in Table 3.

The first HAI interval (below the lower limit) defines countries of less than average value of the HAI index. Initially this category consisted of only one country—Cyprus, but during the research period two more countries joined this category—Ireland and Luxembourg (the last one dropped slightly below the lower limit). The second HAI interval (between the lower and upper limits) indicates the category of countries where the level of the HAI index is average. This category consists of the majority of the examined countries: initially it was sixteen EU Member States (Belgium, Bulgaria, Denmark, Estonia, Ireland, Spain, Croatia, Italy, Latvia, Lithuania, Luxembourg, Hungary,

Table 2. Normalised values of the initial variables (Z_1, Z_2, Z_3)

Variable	Z_1—Hospital beds (normalised)					Z_2—Physicians (normalised)					Z_3—Public healthcare expenditure (normalised)				
Year	2013	2014	2015	2016	2017	2013	2014	2015	2016	2017	2013	2014	2015	2016	2017
Belgium	1.11	1.10	1.11	1.10	1.09	0.87	0.86	0.86	0.86	0.85	1.33	1.32	1.33	1.31	1.33
Bulgaria	1.28	1.34	1.37	1.39	1.44	1.17	1.15	1.16	1.16	1.17	0.67	0.75	0.70	0.69	0.70
Denmark	0.57	0.51	0.48	0.50	0.50	1.13	1.12	1.12	1.12	1.13	1.42	1.42	1.45	1.43	1.43
Germany	1.55	1.55	1.54	1.54	1.54	1.19	1.19	1.18	1.17	1.17	1.53	1.54	1.59	1.58	1.62
Estonia	0.94	0.94	0.94	0.91	0.90	0.98	0.97	0.98	0.97	0.96	0.75	0.76	0.81	0.82	0.82
Ireland	0.48	0.49	0.55	0.57	0.57	0.79	0.87	0.89	0.89	0.90	1.22	1.14	0.89	0.90	0.88
Spain	0.55	0.56	0.57	0.57	0.57	1.12	1.10	1.10	1.07	1.07	1.07	1.06	1.10	1.07	1.06
France	1.17	1.17	1.16	1.16	1.15	0.91	0.90	0.89	0.88	0.87	1.45	1.47	1.48	1.60	1.59
Croatia	1.10	1.11	1.06	1.05	1.07	0.89	0.91	0.91	0.91	0.93	0.92	0.92	0.95	0.94	0.94
Italy	0.62	0.61	0.61	0.61	0.61	1.15	1.12	1.10	1.11	1.10	1.10	1.11	1.11	1.09	1.08
Cyprus	0.64	0.64	0.65	0.66	0.65	0.94	0.98	1.03	1.06	1.07	0.53	0.50	0.49	0.47	0.47
Latvia	1.09	1.07	1.08	1.09	1.07	0.94	0.93	0.91	0.90	0.88	0.54	0.54	0.56	0.58	0.58
Lithuania	1.37	1.37	1.32	1.28	1.26	1.26	1.24	1.24	1.25	1.26	0.67	0.70	0.74	0.74	0.72
Luxembourg	0.97	0.95	0.94	0.92	0.90	0.83	0.83	0.83	0.81	0.82	0.76	0.75	0.75	0.73	0.74
Hungary	1.32	1.32	1.33	1.34	1.35	0.94	0.96	0.89	0.90	0.92	0.80	0.79	0.80	0.80	0.79
Austria	1.43	1.43	1.43	1.42	1.42	1.47	1.46	1.45	1.44	1.43	1.26	1.28	1.30	1.28	1.29
Poland	1.24	1.25	1.26	1.27	1.28	0.66	0.67	0.67	0.68	0.66	0.75	0.73	0.75	0.76	0.76
Romania	1.25	1.26	1.29	1.31	1.33	0.78	0.78	0.79	0.80	0.81	0.68	0.66	0.65	0.65	0.68
Slovenia	0.85	0.86	0.86	0.86	0.87	0.77	0.80	0.81	0.84	0.85	1.03	1.01	1.03	1.03	0.99
Sweden	0.49	0.48	0.46	0.45	0.43	1.19	1.19	1.19	1.19	1.18	1.52	1.53	1.53	1.53	1.54
Standard deviation	**0.33**	**0.34**	**0.34**	**0.34**	**0.34**	**0.20**	**0.19**	**0.19**	**0.18**	**0.18**	**0.33**	**0.33**	**0.33**	**0.34**	**0.34**

Source: Author's calculations based on Eurostat and OECD data.

Table 3. Values of the aggregated synthetic index of healthcare (HAI), the standard deviation of HAI, the lower and the upper limits of the HAI intervals

Country / Year	2013	2014	2015	2016	2017
Belgium	1.104	1.093	1.101	1.091	1.089
Bulgaria	1.040	1.081	1.077	1.081	1.102
Denmark	1.043	1.016	1.018	1.014	1.021
Germany	1.421[d]	1.426[d]	1.437[d]	1.433[d]	1.442[d]
Estonia	0.889	0.893	0.909	0.901	0.893
Ireland	0.827	0.832	0.778[c]	0.786[c]	0.782[c]
Spain	0.915	0.906	0.921	0.904	0.901
France	1.177[d]	1.179[d]	1.180[d]	1.212[d]	1.205[d]
Croatia	0.969	0.981	0.971	0.967	0.978
Italy	0.957	0.946	0.938	0.933	0.929
Cyprus	0.703[c]	0.706[c]	0.720[c]	0.727[c]	0.730[c]
Latvia	0.854	0.845	0.852	0.858	0.844
Lithuania	1.100	1.103	1.099	1.091	1.079
Luxembourg	0.854	0.846	0.838	0.818[c]	0.820[c]
Hungary	1.021	1.022	1.005	1.014	1.019
Austria	1.387[d]	1.387[d]	1.394[d]	1.380[d]	1.378[d]
Poland	0.881	0.883	0.891	0.903	0.897
Romania	0.903	0.901	0.910	0.920	0.938
Slovenia	0.887	0.887	0.899	0.912	0.905
Sweden	1.065	1.065	1.062	1.054	1.046
Standard deviation[a]	**0.174**	**0.176**	**0.178**	**0.177**	**0.178**
Lower limit[b]	**0.826**	**0.824**	**0.822**	**0.823**	**0.822**
Upper limit[b]	**1.174**	**1.176**	**1.178**	**1.177**	**1.178**

Notes: a—standard deviation of HAI;
b—explanation in the text;
c—the HAI value below the lower limit;
d—the HAI value above the upper limit.

Source: Author's calculation based on Eurostat and OECD data.

Poland, Romania, Slovenia and Sweden) but during the research period two of them (Ireland and Luxembourg) fell into the lower category. The third HAI interval (above the upper limit) defines countries of a more than average value of the HAI index. This category is the most stable: during the whole research period it consisted of three countries: Germany, Austria and France (the last country initially was slightly above the upper limit but later it strengthened its position).

Changes of HAI values for each of the twenty EU countries during the research period of five years are presented at Figure 1. Based on dynamic changes of HAI over time it is possible to identify three groups of countries: the first group of the almost stable HAI value, the second—of the decreasing HAI value and the third—of the increasing HAI value. The first group (of almost constant

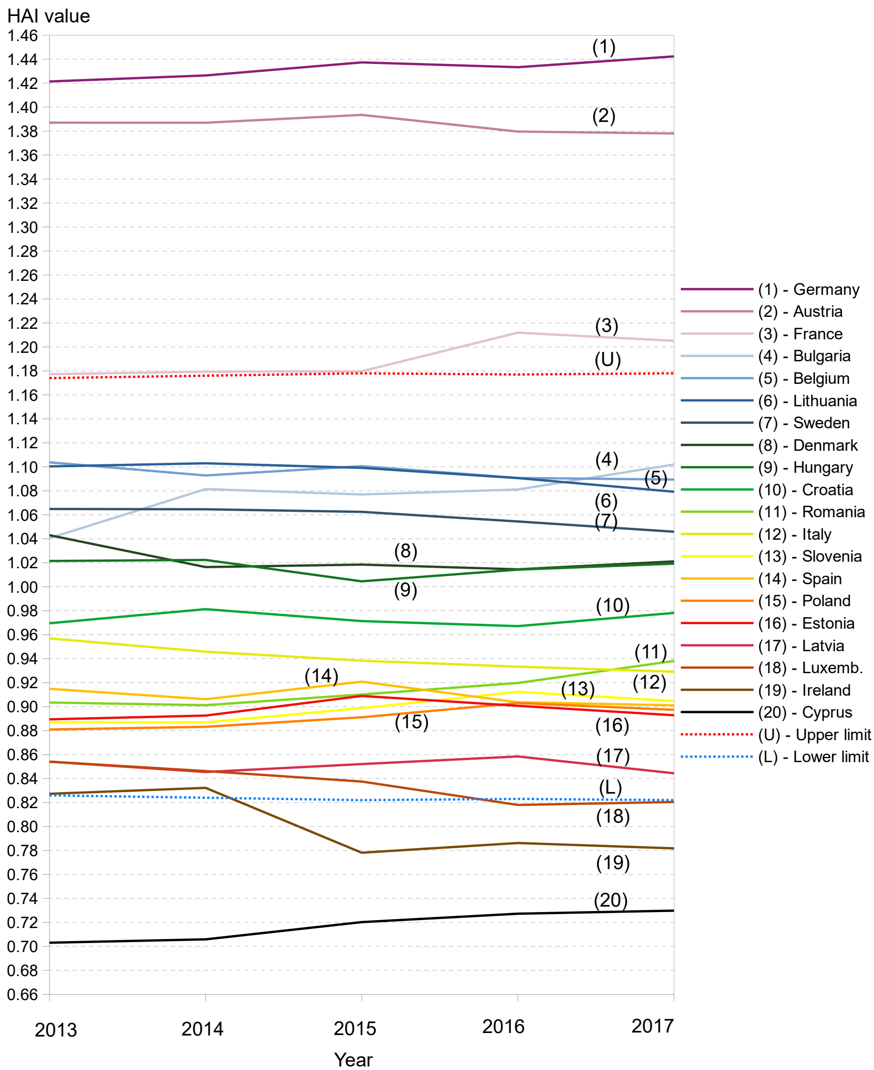

Figure 1. Changes of the HAI values for twenty EU Member States during the period of research (2013–2017)

Source: Author's calculation based on Eurostat and OECD data.

HAI value) consists of eight EU countries (Austria, Belgium, Croatia, Estonia, Hungary, Latvia, Slovenia and Spain). In this group there is no evident tendency despite the slight fluctuation of the HAI values. The second group of the decreasing HAI value consists of six countries (Denmark, Italy, Ireland, Lithuania, Luxembourg and Sweden). Decline in HAI value was not great and its maximum was less than 6% of initial value (in case of Ireland). Most of these countries have reduced the number of hospital beds, except Ireland (steep fall in public expenditures for healthcare) and Italy (decrease both in hospital beds and health expenditures). The third group of increasing HAI value comprises six countries: Bulgaria, Cyprus, France, Germany, Poland and Romania. The increasing dynamics of HAI were mild—maximum (almost 6% of initial value) was noticed in the case of Bulgaria. In this group the rising tendency of HAI was mostly due to a relative[3] increase in the number of hospital beds (Bulgaria, Poland and Romania), in the number of physicians (Cyprus and Romania) and in public expenditures for healthcare (France and Germany).

3. Discussion

Integrated quantitative evaluation of healthcare systems is a difficult issue. There are lots of simple indicators that reflect specific and narrow features of healthcare. In the labyrinth of the variety of these indicators it is a challenge to find a wider perspective. The solution could be an aggregation of some simple indicators into a single synthetic index. The implementation of synthetic indices to an evaluation of multidimensional phenomena (including the field of health status and healthcare) is recommended in literature (e.g. Leuschner, 1991; Jankowiak, 2011; Rothenberg et al., 2015; Fagigh & Sazegar, 2019; Jankowiak & Rój, 2020).

The synthetic HAI index proposed in this paper combines three simple indicators describing different aspects of a healthcare system. Two indicators: the number of practising physicians and the number of hospital beds, reflect a broadly understood healthcare infrastructure. The third indicator (the public expenditures on healthcare) is related to financial conditions of a healthcare system. In this way the abovementioned indicators could be perceived as estimators of three basic (not only in the field of health protection) resources: human, physical and financial capital. These three indicators were chosen due to their suitability for a reliable assessment of healthcare systems proven in many publications and official documents (e.g. European Commission, 2019; OECD / European Union, 2020), and their easy accessibility for a majority of EU countries. Aggregation of these indicators to the one synthetic index creates a use-

[3] In relation to the mean value for all countries in the given year. More information on "relative" meaning is available in Section 3.

ful tool for simultaneous evaluation of three different perspectives (related to human, physical and financial resources) in a single measure.

Simple indicators aggregated in this research quantitatively describe input outlays used in health protection. It means that HAI is a strictly quantitative index of resources. There are many other indicators (such as life expectancy, mortality rates, incidences of particular diseases) which reflect the outcomes of the functioning of a healthcare system. Although they do not explain how particular results of a healthcare system were achieved they could be perceived in a model as dependent variables of output. In further research it will be possible to expand the proposed model and to compare the index of input resources with outcomes measured by chosen quantitative indicators.

In this research the usage of the aggregation procedure is based on the assumption that under real conditions a substitution mechanism between different healthcare resources occurs. Three initial indicators: the number of physicians, the number of hospital beds and the public expenditures on health could be considered as estimators of human, physical and financial capital respectively. A country which structures its healthcare based mostly on one type of capital could be compared with another using different mixture of resources. For example, Poland has a healthcare system with relatively high number of hospital beds, low number of medical professionals and low public expenditures on health. But the value of the HAI index for Poland is in the middle range due to arithmetical substitution between considered resources. Additionally the standard deviation of the HAI index is substantially lower than standard deviations of each of the initial indicators which could be evidence of resources' substitution as well. There are some theoretical and observational prerequisites that such substitution really occurs. For example medical professionals better equipped with physical capital are able to work more efficiently, higher expenditure on health could lead to better usage of human and physical resources (in extra paid working hours), excessive employment in healthcare allows a compensation for insufficient equipment or low financing by having an additional workforce. In this light a lower standard deviation of HAI than standard deviations of each of the simple indicators probably reflects not only arithmetical but also a real substitution of resources. This phenomenon surely needs further investigation, for example, with usage of HAI compared with the above mentioned quantitative indicators of a healthcare system's outcomes. It will allow the establishment of real resources' substitution rates which could be integrated into the system of weights in the aggregation formula of HAI and the discovery of more than three relevant initial indicators which might be used to extend the aggregation model.

Application of the HAI index to assess twenty EU Member States' healthcare systems enables both the analysis of a single country healthcare level over time and comparisons among countries as well. The standard deviation of the HAI index is at a minor level (about 17.5% of the mean value) that indicates mild differences among the examined countries in health protection. An analysis of the HAI standard deviation in consecutive years shows slightly increasing variation. It could be evidence of rising interstate disparities in healthcare. This finding is unexpected because there is a mechanism of soft co-ordination in the field of health protection in the European Union and earlier research showed an opposite effect of healthcare convergence (Jankowiak, 2010, 2011). Suspicions of a declining level of interstate healthcare convergence in the European Union surely needs further investigation including application of the HAI index presented here to their methodology.

The ranking of countries with regard to their values of the HAI index shows relative interstate differences in the level of health protection. A healthcare system of a country with higher value of the HAI index could be perceived as a better provider of health protection compared to a country with a lower value of HAI. Nevertheless the HAI index is not suitable for the assessment of an absolute level of health protection. The adopted formula of the raw variables' normalisation referring to their mean value in each of research periods leads to changes in normalised variables and HAI values according to the shift in raw variables' mean values in consecutive years. It means that a HAI value reflects the relative healthcare level of a given country in relation to other countries in a particular year. This model of normalisation was applied because it does not change the values of standard deviations between series of raw and normalised variables which allows the protection of the original variability among countries. Additionally the normalisation procedure in each of the evaluated years is based on data originating from only a given year and it does not require the establishment of a constant base of normalisation in the past, which reduces the vulnerability of this method to changes in a methodology of collection of raw variables by the European Union statistical system.

Analysis of HAI changes over time shows three different paths of development among the EU countries. Eight countries (Austria, Belgium, Estonia, Hungary, Latvia, Slovenia, Spain and Croatia) reveal almost constant values of HAI in time series. It means that their relative positions to an average level of health protection (determined by mean values of component simple indicators) remain stable. It does not show that in these countries that there were no changes in healthcare at all but it means that these changes followed the average (for all examined EU countries) alterations of health protection. The increasing HAI indicates countries: Bulgaria, Cyprus, France, Germany, Poland and Romania in which the development of healthcare resources (some or all of them) is faster than EU average. Very interesting is the path of decreasing HAI. Here are countries (Denmark, Italy, Ireland, Lithuania, Luxembourg and Sweden) in which healthcare resources rise more slowly than the average or even decline. The strength of the HAI index is a presentation of relative changes referred to an EU average level of healthcare which makes international comparisons much easier.

Conclusions

The aggregated synthetic index of healthcare (HAI) proposed in this paper joins three different perspectives of health protection in a single measure. It allows the comparison of national healthcare systems exploiting a different mixture of key resources: human, physical and financial. The dynamic in time series comparisons of countries' positions in a peer ranking is possible as well.

Analysis of twenty EU countries with the use of HAI reveals that the majority of them provides at least the average level of healthcare. At the beginning of the research only one country (Cyprus) had HAI below the average level but during five years' observation two others (Ireland and Luxembourg) joined this category. Assessment of HAI dynamics shows that except countries of stable and rising values HAI six of them presented a decreasing path of development. These countries are at risk of a fall in health protection to below the average level or the preservation of the low status.

The methodology of HAI is based on the assumption of a substitution between resources employed in providing health protection. In this research equal rates of resource substitution were adopted but further investigations might be helpful to establish what a real substitution level occurs in healthcare systems. Additionally the HAI aggregation model is flexible and could be extended to other initial variables suitable in particular implementations of the HAI index.

References

Biesen van, W., Van Der Straeten, C., Sterckx, S., Steen, J., Diependaele, L., & Decruyenaere, J. (2021). The concept of justifiable healthcare and how big data can help us to achieve it. *BMC Medical Informatics and Decision Making*, *21*(87), 1-17. https://doi.org/10.1186/s12911-021-01444-7

European Commission. (2019*). Joint Report on Health Care and Long-Term Care Systems & Fiscal Sustainability. Country Documents 2019 Update*. (European Economy Institutional Papers No. 105). Retrieved from https://ec.europa.eu/info/publications/economic-and-financial-affairs-publications_en

Eurostat. (2020). *Health. Main tables*. Retrieved from https://ec.europa.eu/eurostat/web/health/data/main-tables

Faghih, N., & Sazegar, M. (2019). A taxonomy of country performance based on GDP and innovation indicators for the Group of Twenty (G20). In N. Faghih (Ed.), *Globalization and development. economic and socio-cultural perspectives from emerging markets* (pp. 163-200). Cham: Springer Nature Switzerland AG. https://doi.org/10.1007/978-3-030-14370-1_7

Gerrits, R. G., Kringos, D. S., van den Berg, M. J., & Klazinga, N. S. (2018). Improving interpretation of publically reported statistics on health and healthcare: The Figure Interpretation Assessment Tool (FIAT-Health). *Health Research Policy and Systems*, *16*(20), 1-12. https://doi.org/10.1186/s12961-018-0279-z

Głodowska, A. (2019). Comparative international entrepreneurship: Theoretical framework and research development. *Entrepreneurial Business and Economics Review*, *7*(2), 235-248. https://doi.org/10.15678/EBER.2019.070213

Jankowiak, M. (2010). Konwergencja ochrony zdrowia w państwach Unii Europejskiej. *Polityka Społeczna*, *7* (436), 6-10. Retrieved from https://polityka-spoleczna.ipiss.com.pl/resources/html/article/details?id=200917

Jankowiak, M. (2011). Ocena (z użyciem cechy syntetycznej) stopnia międzypaństwowej konwergencji systemów ochrony zdrowia w Unii Europejskiej. In E. Nojszewska (Ed.), *System ochrony zdrowia* (pp. 324-336). Warszawa: Wolters Kluwer.

Jankowiak, M., & Rój, J. (2020). Regional variability in the access to cardiac rehabilitation in Poland. *Healthcare*, *8*(4), 468. https://doi.org/10.3390/healthcare8040468

Leuschner, D. (1991). A mathematical model for classification and identification. *Journal of Classification*, *8*, 99-113. https://doi.org/10.1007/BF02616250

Manera, C., Navinés, F., & Franconneti, J. (2017). United States of America, European economy and inequality: A perspective from the economic history, 1910-2010. *The European Journal of Comparative Economics*, *14*(1), 59-87. https://doi.org/10.25428/1824-2979/201701-59-87

Mousa, M. (2018). Inspiring work-life balance: Responsible leadership among female pharmacists in the Egyptian health sector. *Entrepreneurial Business and Economics Review*, *6*(1), 71-90. https://doi.org/10.15678/EBER.2018.060104

OECD / European Union. (2020). *Health at a glance: Europe 2020: State of health in the EU cycle.* Paris: OECD Publishing. https://doi.org/10.1787/82129230-en

OECD. Stat. (2020). *Health expenditures and financing*. Retrieved from https://stats.oecd.org/Index.aspx?DataSetCode=SHA

Pera, J. (2016). The risk of the increasing divergence of the eurozone and the problem of macroeconomic imbalances in a three-gap model. *Economics and Business Review*, *2*(16), 18-38. https://doi.org/10.18559/ebr.2016.2.2

Rothenberg, R., Stauber, C., Weaver, S., Dai, D., Prasad, A., & Kano, M. (2015). Urban health indicators and indices—current status. *BMC Public Health*, *15*(494), 1-14. https://doi.org/10.1186/s12889-015-1827-x

Schenkman, S., & Bousquat, A. (2021). From income inequality to social inequity: Impact on health levels in an international efficiency comparison panel. *BMC Public Health*, *21*(688), 1-17. https://doi.org/10.1186/s12889-021-10395-7

Zahid, A., Poulsen, J. K., Sharma, R., & Wingreen, S. C. (2021). A systematic review of emerging information technologies for sustainable data-centric healthcare. *International Journal of Medical Informatics*, *149*(104420), 1-20. https://doi.org/10.1016/j.ijmedinf.2021.104420

Aims and Scope

The **Economics and Business Review** is a quarterly journal focusing on theoretical, empirical and applied research in the fields of Economics and Corporate and Public Finance. The Journal welcomes the submission of high quality articles dealing with micro, mezzo and macro issues well founded in modern theories and relevant to an international audience. The EBR's goal is to provide a platform for academicians all over the world to share, discuss and integrate state-of-the-art Economics and Finance thinking with special focus on new market economies.

The manuscript

1. Articles submitted for publication in the **Economics and Business Review** should contain original, unpublished work not submitted for publication elsewhere.
2. Manuscripts intended for publication should be written in English, edited in Word in accordance with the **APA editorial** guidelines and sent to: secretary@ebr.edu.pl**.** Authors should upload two versions of their manuscript. One should be a complete text, while in the second all document information identifying the author(s) should be removed from papers to allow them to be sent to anonymous referees.
3. Manuscripts are to be typewritten in **12' font in A4 paper** format, one and half spaced and be aligned. Pages should be numbered. Maximum size of the paper should be up to 20 pages.
4. Papers should have an abstract of about 100-150 words, keywords and the Journal of Economic Literature classification code (**JEL Codes**).
5. Authors should clearly declare the aim(s) of the paper. Papers should be divided into numbered (in Arabic numerals) sections.
6. **Acknowledgements** and references to grants, affiliations, postal and e-mail addresses, etc. should appear as a separate footnote to the author's name a, b, etc and should not be included in the main list of footnotes.
7. **Footnotes** should be listed consecutively throughout the text in Arabic numerals. Cross-references should refer to particular section numbers: e.g.: See Section 1.4.
8. **Quoted texts** of more than 40 words should be separated from the main body by a four-spaced indentation of the margin as a block.
9. **References** The EBR 2017 editorial style is based on the **6th editio**n of the Publication Manual of the American Psychological Association (**APA**). For more information see APA Style used in EBR guidelines.
10. **Copyrights** will be established in the name of the **E&BR publisher**, namely the Poznań University of Economics and Business Press.

More information and advice on the suitability and formats of manuscripts can be obtained from:

Economics and Business Review
al. Niepodległości 10
61-875 Poznań
Poland
e-mail: secretary@ebr.edu.pl
www.ebr.edu.pl

Subscription

Economics and Business Review (E&BR) is published quarterly and is the successor to the Poznań University of Economics Review. The E&BR is published by the Poznań University of Economics and Business Press.

Economics and Business Review is indexed and distributed in Scopus, Claritave Analytics, DOAJ, ERIH plus, ProQuest, EBSCO, CEJSH, BazEcon, Index Copernicus and De Gruyter Open (Sciendo).

Subscription rates for the print version of the E&BR: institutions: 1 year – €50.00; individuals: 1 year – €25.00. Single copies: institutions – €15.00; individuals – €10.00. The E&BR on-line edition is free of charge.