Assessment of the Relationship between Health and Sustainable Development in the Countries of the European Union

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Abstract

The social dimension of sustainable development (SD) and those aspects of it related to human health are crucial for SD. By means of hierarchical cluster analysis (HCA) and principal component analysis (PCA) the European Union countries and other three developed countries were assessed using selected indicators reflecting aspects of health related to SD. Five indicators reflecting these aspects at the macroeconomic level were used. These were a pair of objective indicators, a pair of subjective indicators and one indicator reflecting resources for health care. They were applied in order to cluster the 31 countries for each year in the period 2011 – 2015 and also for the whole period. Four clusters were created for the years 2011 – 2014, three clusters for 2015, and five clusters for the overall period. Switzerland was evaluated as the best performing country in the sample, and Lithuania as the worst. Czechia exhibited a significant shift towards higher sustainability.

Keywords: *health, Hierarchical Cluster Analysis (HCA), Sustainable Development (SD), Principal Component Analysis (PCA)*

JEL Classification: I15, I18, Q01

Introduction

According to the most quoted definition of the World Commission on Environment and Development (WCED, 1987), sustainable development (SD) is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. The three-pillar approach to SD is based on that view of SD which refers simultaneously to economic, social

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and environmental systems, all of which must be sustainable at the same time. This is because each of these pillars is independently crucial and the pillars are interlinked. Moreover, the fourth, institutional dimension is emphasized as the fourth pillar of SD because of its necessity in supporting progress in the previous three pillars and in SD generally (United Nations et al., 2003). The focus on the economic, environmental and social dimensions of SD must also be understood in such a way as to include the human dimension as well (see more in Drastichová, 2018b).[1] SD is of great importance in the European Union (EU). It is its fundamental objective enshrined in its primary law (European Union, 2012). The EU Sustainable Development Strategy (EU SDS) was adopted in 2001 and renewed in 2006. In 2015, the United Nations (UN) adopted the 2030 Agenda for Sustainable Development and its 17 Sustainable Development Goals (SDGs). They have given a new impetus to global efforts for achieving SD. The EU, in coordination with its Member States, is committed to support the implementation of the 2030 Agenda. In compliance with that, the EU SDS was replaced with the EU Sustainable Development Goal (SDG) indicator set in 2017.

The analysis carried out in this paper focuses on the SDG 3 topic "good health and wellbeing" in the EU SDG indicator set, which is of crucial importance for SD. Health represents the basic constituent of wellbeing. Continuous increases in wellbeing should be one of the main results of strategies aimed at SD. These aspects predominantly reflect the social dimension of SD, but aspects related to the economic, environmental, and institutional dimension are included as well (see more in United Nations et al., 2003). Accordingly, the human dimension outlined above is reflected. The health of the population is determined by the type of health system as well as the resources used within this system. The performance of the health system can be evaluated according to the relationship between its resources and outcomes (see e.g. Elola, Daponte and Navarro, 1995; WHO, 2005). However, there are many factors affecting health outcomes and these relationships are comprehensive (see e.g. Nixon and Ulmann, 2006). Therefore, this study rather focuses on discovering dis/similar features and trends in the group of developed countries in the relationships between healthcare resources and selected health outcomes in order to derive conclusions for SD. The methodology applied was chosen in order to achieve this aim.

The aim of this paper is to cluster the sample, which includes the 28 EU countries along with Iceland, Norway and Switzerland, in accordance with their performance in the indicators reflecting health inputs and outcomes, and to evaluate their development in relation to SD. The three non-EU countries were included because of their close relations to the EU countries and for the purpose

[1] The study of Suchacek et al. (2018) emphasised the spatial dimension of SD.

of comparisons. A cluster analysis and a principal component analysis (PCA) are applied as main methods. This paper often refers to selected groups of countries as follows. The Northern countries consist of Denmark, Finland, Norway, Sweden and Iceland; Greece, Italy, Portugal and Spain are the Southern countries; the Baltic countries comprise Estonia, Latvia and Lithuania; the small countries are Cyprus, Malta, Luxembourg and Iceland; and the new member countries are those which joined the EU in 2004 or later.

1. Theoretical Background and Literature Review

This section introduces the approach to SD applied in this paper in more detail. The literature review includes works that use similar methodologies and consider relevant aspects of health.

The human development approach is considered due to its important role in the overall SD. This point of view and aspects are considered in the Human Development Reports (HDR) of the United Nations Development Programme (UNDP). This approach is concentrated on expanding the richness of human life, rather than simply the richness of the economy in which human beings live. It is focused on people and their opportunities and choices (UNDP, 2018). These aspects are reflected in the Human Development Index (HDI) and its adjusted alternative, i.e. Inequality-adjusted Human Development Index (IHDI), the main indicators included in the HDR. However, many issues are important to reflect this approach (see more in Drastichová, 2018b). In this paper, certain indicators for the social dimension (and affecting the other dimensions) of SD at the macroeconomic level reflecting aspects of health were chosen.

Medical science suggests that heredity, environment, behaviours, and fortune all play a part in determining underlying health. For policymakers, the question is what policy can and should do to address these differences. The consequent policy questions mainly concern the prevention of poor health, primarily by influencing behaviour and environmental factors, and compensating for the consequences of health differences (Glied and Smith, 2011). Health systems are responsible for delivering services that improve, maintain or restore the health of individuals and their communities (WHO, 2019a). Policy decisions that affect the health sector (given its size) can have important macroeconomic consequences. Jack (2011) summarizes a complex evidence base on the impact of health on income and well-being. There is strong evidence of a potentially strong impact of improved health on the productivity and wellbeing of individual workers. However, this potential result of health interventions can be fully effective only if delivered efficiently and aligned (among others) with properly functioning

education services and labour markets. The extent to which the individual benefits of improved health can lead to improved macroeconomic performance remains a question.

A number of studies evaluated SD in the EU using cluster analysis. Allievi et al. (2011) applied a Hierarchical Cluster Analysis (HCA) to the EU-27 countries based on their performance measured by the EU Sustainable Development Indicators (SDIs). The authors produced the results of the hierarchical agglomerative clustering carried out on the EU-27 countries for the three dimensions of sustainability in 1997 and 2005. The social, economic and environmental dimensions were evaluated. In the social dimension, the indicators included are Total long-term unemployment rate (%); Life expectancy at age 65 for males; Suicide death rate; Persons with low educational attainment (%); and Early school-leavers (%). Cyprus was the best performing country in 1997 and Sweden in 2005 (Cyprus was the fourth best performing country), while the worst performance was shown by Hungary in 1997 and Portugal in 2005. Although Cyprus showed the high performance in the social dimension of SD, its performance in the environmental pillar was very low. According to the strong sustainability principle, one dimension cannot be offset by the others and thus the SD path cannot be pursued in this way. On the other hand, Sweden achieved a high performance in all three dimensions. Although the above-mentioned work analysed all three dimensions of SD, this paper is focused on the social (human) dimension and especially on the indicators related to health which are important for SD as a whole. It is taken into account that these aspects affect all the remaining dimensions of SD.

This paper also extends and improves the analysis carried out by Drastichová (2018a). That work evaluated the performance in selected aspects of the social dimension of SD of the 28 EU countries, along with Iceland, Lichtenstein, Norway and Switzerland. An HCA was applied to group the countries firstly according to their performance achieved in Life expectancy at birth (LE) and Death rate due to chronic diseases (DR), and secondly according to these two indicators along with Current health care expenditure (HE) (Percentage of GDP). Due to the missing HE indicator data for some countries in some years, the analysis was carried out only for the years 2014 and 2015 separately, as well as for both years together. The HCA was applied to the first two indicators (LE and DR) in all 32 countries as well as to all three indicators in 30 countries were included (Malta and Switzerland were excluded). In the analysis of two indicators four clusters and in the analysis of three indicators five clusters were formed. In the analysis of three indicators, cluster 1 was composed of the developed EU countries, including Belgium, the Netherlands, Denmark, Sweden, Germany, France, and Austria. Norway shifted to this cluster from cluster 4 in 2015, as its DR decreased and its

LE increased. Cluster 1 showed the highest average HE ratios in all analyses. However, this cluster was surpassed in the average performance in LE by cluster 5 and cluster 4 in all analyses. For 2015, all four Southern countries, Slovenia, Finland, Iceland and the UK shifted from cluster 4 to cluster 5. On the other hand, Lichtenstein, Luxembourg and Cyprus shifted from cluster 5 to cluster 4 (these three countries are the only countries forming cluster 5 according to all indicator values).

In 2015, these three countries, along with Ireland, forming cluster 4, exhibited the highest average performance in LE and DR and the second lowest average HE ratio, following cluster 2. Cluster 2 had the same composition in the analysis of two and three indicators as well as in all three analyses within each of them. The countries are Bulgaria, Romania, Latvia, Lithuania and Hungary, which are the worst performing countries having the lowest values of the LE indicator and the highest values of the DE indicator. Romania and Latvia also had the lowest HE ratios in the sample. Cluster 3 was the second worst performing cluster in both analyses as well as in the partial analyses within them. Cluster 3, consisting of the same countries in all the analyses, had medium average HE ratios and its average performance in the LE and DR indicator was the second lowest. Only new member countries were included in this cluster as well, that is the CR, Estonia, Poland, Croatia and Slovakia. Generally, a poor performance in LE and DE along with relatively low HE ratios (except for Bulgaria) was exhibited by new member countries, apart from Malta, Cyprus and Slovenia. All the non-EU countries had a high performance. Switzerland and Lichtenstein were evaluated as the best performing countries having high LEs and low DRs. When compared to that work, this study also uses two subjective indicators reflecting the quality of healthcare. The longer time series were obtained using the data of WHO (2019b) for the HE indicator.

Drastichová and Filzmoser (2019) also clustered the sample containing the 28 EU countries and Norway, according to their sustainability levels and analysed if shifts closer towards the path of SD took place. Nine indicators were selected from the EU SDG indicator set to measure sustainability and its change over the period 2012 – 2016 to reflect SD. An HCA and a principal component analysis (PCA) were applied. The indicators chosen represent all three dimensions of SD along with the institutional dimension and the issue of decoupling. The LE indicator was chosen as one of the indicators representing the social dimension of SD, and particularly SDG 3, which is entitled as *good health and wellbeing*. Overall, cluster 1, which included the Northern countries, the Benelux countries, Germany, Austria, France, the UK, as well as Ireland (from 2014 onwards), was evaluated as the best performing cluster in relation to the examined indicators. Cluster 2, which was composed of three core countries each year (Bulgaria, Romania and

Latvia), is evaluated as the worst performing cluster. Slovakia, Hungary, Lithuania and Croatia were also included in 2012. Only Lithuania and Croatia returned to this cluster (in 2015). Cyprus and Portugal were included in cluster 2 in 2015, forming the closest linkage within this cluster. Cluster 3 included the transitive economies – the CR, Estonia, Slovenia and Poland in each year, along with Slovakia and Hungary, which shifted there from cluster 2 in 2013. Cyprus was included in the first three years and Malta in 2012, 2015 and 2016. The core countries of cluster 4 are four Southern countries. Although Portugal shifted to cluster 2 for one year, this country belongs to cluster 4. Cyprus is a cluster 4 country according to all indicator values as well, although it moved into this cluster only in the last monitored year, 2016. Malta is also a cluster 4 country according all indicator values. This work was presented in order to evaluate how the results differ depending on whether all dimensions of SD are evaluated together or only the health aspects.

In contrast, Drastichová (2019) evaluated only aspects related to health and standard of living in the sample of 31 countries (the EU-28 plus Iceland, Norway, and Switzerland). The indicators used to reflect health outcomes are LE; Healthy life years in absolute value at birth for females (HLYf) and for males (HLY m); and DR. Concerning healthcare inputs (resources), the indicator used is HE (percentage of GDP).[2] Two partial expenditure ratios in classification by healthcare financing schemes are also used to reflect prevailing healthcare system models (government schemes and compulsory contributory health insurance schemes). Data in two years (2015 and 2016) were used and an HCA applied. The core cluster 2 countries, which are the new member countries, apart from Malta, Cyprus and Slovenia, were the worst performing countries. Cluster 1, containing the core developed countries – Austria, Germany, France, Switzerland and the Benelux countries, was evaluated as the second-best performing cluster in both years, although its average HE ratios and GDP per capita were the highest. On the other hand, countries, which shifted from cluster 4 to cluster 3, referred to as cluster 4 – 3 countries: Iceland, Ireland, Malta, Norway and Sweden, were evaluated as the best performing countries, along with the core cluster 3 countries (Italy and Spain), and Cyprus. Other four countries shifted from cluster 3 (2015) to cluster 4 (2016) (cluster 3 – 4 countries).Two Northern countries (Denmark and Finland), one Southern country (Portugal) and the UK are included in this group (the only four countries included in cluster 4 in 2016). Their performance, however, was significantly lower, than that of cluster 4 – 3 countries. The type of healthcare system model does not seem to be a factor that significantly affects performance.

[2] The meaning of abbreviations is the same as in the previous study (Drastichová and Filzmoser, 2019).

However, this system was an important factor for assigning the countries into clusters. Cluster 1 and 2 countries are the countries applying the Bismarck model (except for Latvia) and cluster 3 and 4 are those applying the Beveridge model (as regards Greece it was not quite clear to which model it should be assigned). The positive relationship between GDP per capita and the HE ratio can be identified after omitting some outliers (especially Luxembourg). Between these two indicators and the performance in LE and DR the relationship is much more significant than between them and the HLY indicators.

CESifo (2008) provided the classification of health care systems into basic models and described their application in the EU countries. This can help determine similarities between the values of variables analysed in the sample. However, according to Linden and Ray (2017), among countries with large public shares of health expenditures, there are few differences in terms of health outcomes stemming from whether public funds are derived from taxes or social security contributions. This was also confirmed by Drastichová (2019). Therefore, the type of health care system models is not analysed in this study.

Nixon and Ulmann (2006) reviewed key studies which consider the relationship between health expenditure, among other explanatory variables, and health outcomes, using macro-level data. According to these authors, relatively few studies have managed to find a link between healthcare expenditure and health outcomes, because there can be other important factors affecting health outcomes, and particularly life expectancy (such as diet, life-style or environment). Accordingly, establishing causal relationships between these variables is complex.

The innovation of this study lies in the analysis of both objective and subjective indicators reflecting health outcomes along with the indicator reflecting healthcare resources by means of the HCA and PCA. This methodology was chosen due to difficulties in establishing causal relationships between health expenditure and health outcomes (see more in Nixon and Ulmann, 2006).

2. Data and Methodology

In this section the source of data used, the indicators, including the rationale behind their selection, and the methodology applied in this paper are introduced.

2.1. Data and Indicators Used

Due to the macroeconomic focus of this paper, relevant indicators for the macroeconomic level were chosen. They reflect the above-indicated aspects of health at this level (see section 1). In the selection, a focus on SD was especially

considered. Five indicators were applied. All the indicators are explained in Table 1 (the abbreviations indicated in Table 1 are used in the following text). It was considered that an important factor of functioning health systems are resources, which is represented by the HE indicator. WHO (2019b) was used as the source of the data.

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Indicators Included in the HCA and the PCA

Indicator	Description
Current health expenditure – % GDP (HE)	The indicator quantifies the economic resources dedicated to health functions, excluding capital investment.
Death rate due to chronic diseases by sex – number per 100 000 persons aged less than 65 (DR)	The standardised death rate of chronic diseases: considered premature if it occurs before the age of 65; the rate – calculated by dividing the number of people under 65 dying due to a chronic disease by the total population under 65; this value – then weighted with the European Standard Population; chronic diseases included in the indicator: malignant neoplasms, diabetes mellitus, ischaemic heart diseases, cerebrovascular diseases, chronic lower respiratory diseases and chronic liver diseases.
Life expectancy at birth – years (LE)	The mean number of years that a new-born child can expect to live if subjected throughout his life to the current mortality conditions.
Self-reported unmet need for medical examination and care by sex – % of population aged 16 and over (UN)	The share of the population aged 16 and over reporting unmet needs for medical care due to one of the following reasons: 'Financial reasons', 'Waiting list' and 'Too far to travel' (all three categories are cumulated); a person's own assessment of whether he or she needed medical examination or treatment (dental care excluded), but did not have it or did not seek it. The data stem from the EU Statistics on Income and Living Conditions (EU SILC).
Share of people with good or very good perceived health – % of population aged 16 or over (PH)	A subjective measure on how people judge their health in general on a scale from "very good" to "very bad"; expressed as the share of the population aged 16 or over perceiving itself to be in "good" or "very good" health; can be a good predictor of people's future health care use and mortality. The data stem from the EU SILC.

Note: For the PH and UN indicators the data were not available for Iceland in 2013. The 2013 values were calculated as the arithmetic mean of the 2012 and the 2014 values.

Source: Eurostat (2019).

Moreover, two pairs of indicators representing some of the crucial aspects related to health were chosen. The first pair includes the objective indicators, i.e. the DR and LE indicators, while the second includes the subjective indicators, i.e. the UN and PH indicators. For the first indicator in the pair the lowest possible value is required, while for the second one the highest possible level is desirable. This complies with SD. The DR indicator was chosen because only the developed countries are included in the analysis. This means that chronic diseases play a crucial role in determining health in such countries. The LE indicator can be regarded as a basic indicator reflecting the efficiency of health interventions. The subjective indicators were also used to reflect broader aspects, including those indicated above. All these four indicators (two pairs of indicators) are included in the group of SDG 3 indicators of the EU SDG indicator set. The EU SDG indicator set is composed of 100 indicators that are structured along the 17

SDGs. Monitoring SDG 3 in an EU context focuses on progress made in enabling EU citizens to live healthy lives, by assessing health determinants, causes of death and access to health care (Eurostat, 2019).

2.2. Methodology

Cluster analysis was chosen as a suitable methodology for this study, because it classifies countries by similarities of values of variables selected. It is an exploratory data analysis tool for sorting different objects (or cases, observations) into groups in a way that the degree of association between two objects is maximal if they are part of the same group and minimal otherwise (Mooi and Sarstedt, 2011). HCA is a method for cluster analysis which attempts to identify relatively homogeneous groups of cases (or variables) based on selected characteristics. Hierarchical clustering has an added advantage over K-means clustering in that it results in a tree-based representation of the observations, called a dendrogram. The height of the cut to the dendrogram controls the number of clusters created (UC, 2019). This is the reason why this method was chosen. The other features of the methodology chosen can be justified as well. Ward's method is applied as a cluster method. The squared Euclidean distance was chosen from the measures for interval to specify distance. This was decided because quantitative variables were used. The variables included were measured in different units. Therefore, the Z-scores were chosen from the available standardization methods. The formula expressed by Equation (1) shows that the Z-score is the indicator value minus the mean value and the resulting value is divided by the standard deviation (Aldenderfer and Blashfield, 1984; Meloun and Militký, 2002).

$$Z = \frac{X - \mu}{\sigma} \tag{1}$$

In Equation (1), X is the value of indicator, μ is the mean value and σ is the standard deviation. The HCA is applied in this paper to create clusters from the sample of 31 countries based on the indicator values of individual years in the period 2011 – 2015. Moreover, the summary analysis was carried out for the values of all indicators in all years.

The second main method, PCA, has its central idea to reduce the dimensionality of a data set in which there are a large number of interrelated variables, while retaining as much as possible of the variation present in the data set. This reduction is achieved by transforming to a new set of variables, the principal components, which are uncorrelated, and which are ordered so that the first few retain most of the variation present in all of the original variables (Jolliffe, 2002). It is necessary to apply this method along with cluster analysis to show certain

trends in a simpler way when several variables are included in the analysis. It can also simplify the overall evaluation. A Pearson correlation is also applied to explain the relationships between the indicator values. It is a number between –1 and 1 that indicates the extent to which two variables are linearly related (Sigma Plus Statistiek, 2018).

3. Results of the Analysis

The development and relationships between the indicators used are evaluated in subsection 3.1. The results of the HCA and the PCA are presented and further analysed and discussed in subsections 3.2 and 3.3.

3.1. Basic Analysis of the Indicators in the Sample

For the initial identification of relationships between the indicators, the Pearson correlation coefficient is used. It exhibited high negative values between the DR and LE indicators in each year (higher than 0.9 in the absolute value). The remaining results are also indicated in the absolute value. In this sample, a slight negative correlation was also observed between the PH and the UN indicator (around (above) 0.3). The HE indicator is positively correlated with both the PH indicator (around (above) 0.5, except for 2015, when the coefficient was 0.455) and the LE indicator (around (above) 0.7, except for the last two years, when its values were 0.697 and 0.676 respectively), and negatively with the UN indicator (around (above) 0.6 in the first three and around (above) 0.5 in the last two years) and the DR indicator (around (above) 0.6, in 2013: 0.703).

In this subsection, the changes in the indicators in the monitored period 2011 – 2015 are briefly summarized in order to explain the cluster assignments and their changes in more detail. The indicators values in all countries in 2011 and 2015 are displayed in Table 2. LE is the only indicator which did not decrease in any country of the sample. It did not change in the UK and the lowest increase of 0.1 years occurred in Germany, France and Iceland. However, the last two countries had among the highest life expectancies in the sample. The highest increases were in the small countries – Luxembourg and Malta, the Northern countries – Finland and Norway and the absolutely highest increase occurred in Estonia (1.4 years). All the remaining countries exhibited lower increases than 1 year. For the second objective indicator, DR, the opposite is true for its development. It increased only in Cyprus and Bulgaria. The lowest decreases occurred in Greece and Malta. The highest decreases in the monitored period were in Romania, Poland, Finland and Estonia (with decreases in excess of 16 persons), and Czechia,

Lithuania, Luxembourg, Hungary and Latvia (with decreases in excess of 20 persons). Latvia boasted a decrease of 29.6 persons (the highest number in the sample).

T a b l e 2

The Values of Indicators Included in 2011 and 2015

C.	PH2011	PH2015	LE2011	LE2015	DR2011	DR2015	UN2011	UN2015	HE2011	HE2015
RO	68	70	74.4	75	246.9	230.9	12.2	9.4	4.68	4.94
LT	46.1	46.3	73.9	74.8	251.2	221.6	16.1	8.4	5.57	5.71
LU	72.6	70.5	81.1	82.4	113.9	85.7	0.6	0.9	6.11	6.19
PL	57.8	57.9	76.8	77.5	176.9	160.9	7.9	7.3	6.23	6.34
LV	44.2	42.8	73.7	74.6	258.7	231.5	2.8	2.9	6.50	6.48
EE	51.9	51.5	76.6	78	174.3	157.6	7.3	12.7	5.82	6.48
CY	75.8	80.3	81.2	81.8	82.7	88.9	4.4	1.5	6.59	6.81
SK	63.4	66	76.1	76.7	210.2	195.2	2.2	2.1	7.42	6.87
HU	55.7	56.4	75.1	75.7	284.2	255.7	2.7	2.6	7.54	7.12
HR	46.6	58.2	77.2	77.5	196.3	180.8	5.1	1.9	7.79	7.15
CZ	59.6	61.3	78	78.7	162.9	141.4	1.1	0.8	6.98	7.24
IR	83.3	82.4	80.9	81.5	113.7	99.9	2.2	2.8	10.71	7.45
GR	76.5	74.1	80.8	81.1	124.6	120.5	7.5	12.3	9.10	8.19
BG	67.2	65.6	74.2	74.7	198.7	202.4	9.8	4.7	7.13	8.20
IS	77.8	76.4	82.4	82.5	94	78.9	3.8	4.3	8.49	8.35
SL	60.5	64.8	80.1	80.9	141.5	131.3	0.1	0.2	8.57	8.50
PT	49.7	46.5	80.7	81.3	119.2	113.7	1.4	3	9.53	8.97
IT	64.6	65.8	82.4	82.7	97.3	88.1	5.9	7.2	8.83	8.99
ES	75.5	72.6	82.6	83	104.4	96.4	0.6	0.6	9.09	9.12
MT	70	71	80.9	82	110.1	105.3	1.1	0.8	8.55	9.36
FI	69.1	69.9	80.6	81.6	117.9	101.6	4.4	4.3	8.95	9.74
UK	77.5	69.8	81	81	119.8	112.5	1.2	2.8	8.42	9.79
BE	73.6	74.6	80.7	81.1	115.5	105.1	1.5	2.4	10.00	10.11
NO	73.3	78.4	81.4	82.4	95.1	81.3	1.6	1.1	8.78	10.11
DK	71.8	71.6	79.9	80.8	124.4	109.5	0.9	1.3	10.15	10.27
AT	68.8	69.9	81.1	81.3	121.9	108.2	0.4	0.1	10.03	10.34
NL	76.4	76.2	81.3	81.6	110.3	98.6	0.4	0.1	10.52	10.39
SE	78.4	77.6	81.9	82.2	88.1	79.1	1.5	1.3	10.68	11.01
DE	64.8	64.6	80.6	80.7	121.4	114.2	1.7	0.5	10.72	11.08
FR	67.6	67.9	82.3	82.4	111.8	104.2	2.3	1.2	11.19	11.50
CH	81.3	79.6	82.8	83	83.4	75.9	0.8	0.5	10.77	11.89

Note: *C.* – Country.

Source: Eurostat (2019).

For the PH indicator, the increase took place in sixteen countries. The highest increase occurred in Croatia (11.6 p.p.), followed by Norway, Cyprus and Slovenia. The highest drop occurred in the UK (–7.7 p.p.). It was followed by three Southern countries – Portugal, Spain and Greece, and Luxembourg. Other countries with relatively high decreases are Switzerland, Bulgaria, Lithuania and Iceland. Apart from the two above-mentioned countries and Estonia, in all remaining new member countries the PH indicator increased. In eighteen countries, the UN indicator decreased, most significantly in Latvia (–7.7), Bulgaria (–5.1), Croatia

(–3.2), Cyprus (–2.9), Romania (–2.8), Germany (–1.2) and France (–1.1 p.p.). Other countries showed decreases lower than 1 p.p. As regards the new member countries, the indicator increased only in Estonia (the highest increase of 5.4 p.p.), Lithuania and Slovenia, whose increase was marginal (0.1 p.p.). Other four countries with relatively high increases (following Estonia) are Greece, Portugal, the UK and Italy. In the remaining countries, the increases and decreases were lower than 1 p.p. In the fourth Southern country, Spain, no change occurred.

The HE indicator, representing resources for health care, increased more significantly in the UK (1.37 p.p.). Norway, Switzerland and Bulgaria experienced increases exceeding 1 p.p. as well. In seventeen countries, their increases were lower than 1 p.p. The highest decrease occurred in Ireland (–3.26 p.p.). In nine countries, their decreases were lower than –1 p.p. Five new member countries were included in this group, i.e. Croatia, Slovakia, Hungary, Slovenia and Lithuania (–0.63, –0.55, –0.42, –0.07 and –0.02 respectively). The HE indicator also declined in two Southern countries – Greece and Portugal (–0.9 and –0.56 p.p. respectively), Iceland (–0.14) and the Netherlands (–0.13 p.p.).

3.2. Results of the Cluster Analysis and the Principal Component Analysis

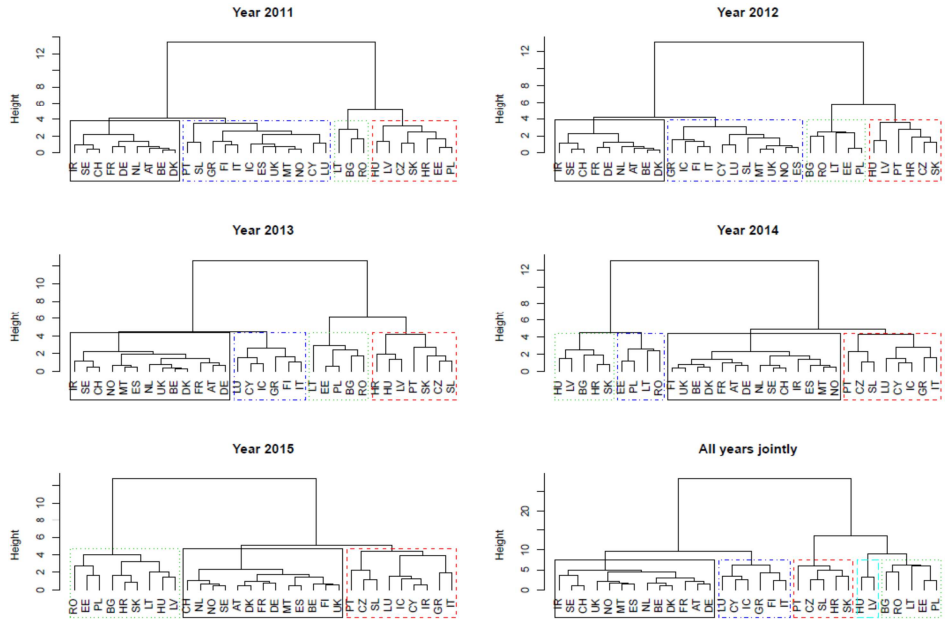
The results of the HCA are presented in Figure 1 and Table 3. Figure 1 contains five dendograms, particularly four dendograms for the individual years and the last one for all indicators in all the years. The overall classification based on the last dendogram is analysed in more detail in subsection 3.3. The divisions into four clusters in the years 2011 – 2014, three clusters in 2015, and five clusters over the whole period were derived from Figure 1. The resulting assignment is displayed in Table 3. The countries that did not change the assignment during the monitored period are referred to as core countries of relevant clusters. The core cluster 1 countries are Austria, two Benelux countries – Belgium and the Netherlands, two Northern countries – Denmark and Sweden, France, Germany and Switzerland. Several countries changed the assignment and joined cluster 1, such as Finland, Norway, Malta, Spain and the UK (referred to as cluster 4 – 1 countries). Ireland was the only country that left cluster 1 after four years. Although there is only one core cluster 2 country, i.e., Bulgaria, assigned to this cluster each year, another two countries can also be referred to as core cluster 2 countries. These are Latvia and Romania. These two countries left cluster 2 only for the year 2014, when they were assigned to cluster 4.

Overall, many changes occurred between cluster 2, 3 and 4. Several countries ended up in cluster 2 in 2015 after being included in all these three clusters, or some of them, in the previous years, but not in cluster 1. These countries include Estonia, Poland, Croatia, Hungary, Lithuania and Slovakia. The first two (referred to as

3 – 2 – 4 – 2 countries) and the second four countries (cluster 3 – 2 countries) experienced the same developments. The second group includes the countries which were assigned to cluster 3 for three years. There is only one core cluster 3 country, which is Czechia, and Portugal was assigned to this cluster for four years, apart from 2011. Slovenia was included in cluster 3 for the three more recent years. In addition to the above-mentioned countries, Cyprus, Greece, Iceland, Italy and Luxembourg ended up in cluster 3 as well, while being included for the last two years. Countries that shifted from cluster 4 to cluster 3 are referred to as cluster 4 – 3 countries. There is no core cluster 4 country, because in 2015 three clusters were created as resulted from the corresponding dendodgram (Figure 1). Some countries were included in cluster 4 in the first three years (Finland, Cyprus, Greece, Iceland, Italy and Luxembourg), some in the first two years (Malta, Norway, Slovenia, Spain and the UK), one country in the first year (Portugal) and some countries only in 2014 (Estonia, Latvia, Poland and Romania).

F i g u r e 1

Cluster Dendograms Constructed for the Values of the Five Indicators Used in the Years of the Period 2011 – 2015 and Based on All Indicators in All Years



Source: Own elaboration.

The shifts between clusters also result from the PCA and this is displayed in Figure 2. This method was applied in order to simplify the overall evaluation and show trends in a simpler way when several variables are included. It can be seen

in both Figure 1 and Figure 2 that some countries are close to one another. They formed common clusters (see also Table 3). Although one might expect that countries which have similar features (economic, location, etc.) would be close to one another, this is not the case for these indicators to a large extent. This particularly applies to the more developed countries. There are no separated groups of the Northern and the Southern countries or the Benelux countries. However, for the small countries and for the new member countries some groups can be identified better. As regards the core cluster 1 countries, France, Germany are very close to one another. Austria is very close to them as well. Concerning the small countries, Cyprus is close to Luxembourg and they both are close to Iceland from 2013 onwards.

Based on all the indicator values (see Table 5), they formed the closest group in cluster 4 along with Italy, Greece and Finland. The second three countries formed close groups as well, but Finland left this cluster in 2014. Spain, the UK, Norway and Malta were close to one another, especially in the first three years and based on all indicator values as well. Neither were the remaining Northern countries closely grouped. Sweden was close to Switzerland and Ireland, except for 2015, when Ireland shifted to cluster 3 (and was closest to Cyprus). The Netherlands was close to them, while in 2015 it was close to the first two countries and Norway. Only in 2015, Norway and Sweden were close to one another. Denmark was close to Belgium and according to all indicator values to the Netherlands as well. Only in 2015, the links were different; Belgium was closest to Finland and the UK.

T a b l e 3

Assignment to Clusters in the Years 2011 – 2015

C.	2011	2012	2013	2014	2015	C.	2011	2012	2013	2014	2015
AT	1	1	1	1	1	**LT**	2	2	2	4	2
BE	1	1	1	1	1	**LV**	3	3	3	2	2
BG	2	2	2	2	2	**LU**	4	4	4	3	3
HR	3	3	3	2	2	**MT**	4	4	1	1	1
CY	4	4	4	3	3	**NL**	1	1	1	1	1
CZ	3	3	3	3	3	**NO**	4	4	1	1	1
DK	1	1	1	1	1	**PL**	3	2	2	4	2
EE	3	2	2	4	2	**PT**	4	3	3	3	3
FI	4	4	4	1	1	**RO**	2	2	2	4	2
FR	1	1	1	1	1	**SK**	3	3	3	2	2
DE	1	1	1	1	1	**SL**	4	4	3	3	3
GR	4	4	4	3	3	**ES**	4	4	1	1	1
HU	3	3	3	2	2	**SE**	1	1	1	1	1
IS	4	4	4	3	3	**CH**	1	1	1	1	1
IR	1	1	1	1	3	**UK**	4	4	1	1	1
IT	4	4	4	3	3						

Note: *C.* – Country.

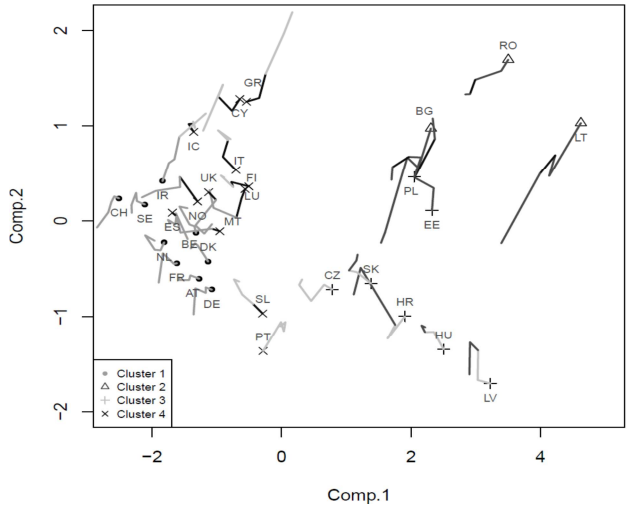
Source: Own elaboration.

As regards the new member countries, Czechia was close to Slovakia and/or Slovenia. Moreover, Portugal often had close linkages to them. Although Slovakia was closest to Croatia in 2014 and 2015 in cluster 2, all these five countries formed a common group, cluster 3, according to all the indicator values (see Table 5). Estonia is closest to Poland each year and overall as well. They experienced the same development and ended up in cluster 2 along with three core cluster 2 countries, which are often close to one another, to these countries as well as other cluster 2 countries. Hungary and Lithuania are very close to one another in each year and based on all indicator values as well. The classification based on all the indicator values is further analysed in subsection 3.3.

Figure 2 resulting from the PCA shows the shifts which took place from 2011 to 2015 for all countries included. Many of the aspects displayed in Figure 2 have already been described. Moreover, it can be clearly seen that the core cluster 1 countries, cluster 4 – 1 countries, cluster 4 – 3 countries and Ireland are separate from the core cluster 2 countries, cluster 3 – 2 – 4 – 2 countries and cluster 3 – 2 countries. Accordingly, two bigger groups can be identified, while Czechia, Slovenia and Portugal are placed on the boundary between these two groups. Czechia is a core cluster 3 country and the two other countries are in cluster 3 in the more recent years. As the first group is composed of the more developed countries and the second group of transitive economies, Czechia and Slovenia have exhibited the most significant progress towards the first group and the direction of development towards this group is clear as well. However, the direction of development in Portugal seems to be towards the second group.

F i g u r e 2

Change in the Assignment of Countries to the Clusters in the Period 2011 – 2015



Source: Own elaboration.

Descriptive statistics for the indicator values of each cluster are included in Table 4.

T a b l e 4

Mean and StD Values of the Indicators in Particular Clusters in the Years 2011 – 2015

Cl./Ind.		Mean	St. D	Cl./Ind.		Mean	St. D	Cl./Ind.		Mean	St. D
1(9)	PH11	74.00	6.35	1(9)	PH12	74.39	6.20	1(13)	PH1	73.79	5.13
	LE11	81.28	0.91		LE12	81.26	0.83		LE1	81.59	0.87
	DR1	110.00	14.63		DR12	107.30	13.50		DR1	103.30	12.10
	HE11	10.53	0.40		HE12	10.70	0.42		HE1	10.30	0.82
	UN1	1.30	0.71		UN12	1.50	0.93		UN1	1.51	0.84
2(3)	PH11	60.43	12.42	2(5)	PH12	58.36	9.09	2(5)	PH1	58.48	9.59
	LE11	74.17	0.25		LE12	75.30	1.38		LE1	75.78	1.43
	DR1	232.27	29.15		DR12	208.00	34.13		DR1	198.88	34.52
	HE11	5.79	1.24		HE12	5.95	1.07		HE1	6.17	1.05
	UN1	12.70	3.18		UN12	9.90	1.92		UN1	10.16	2.25
3(7)	PH11	54.17	6.98	3(6)	PH12	53.85	8.55	3(7)	PH1	55.13	8.82
	LE11	76.21	1.43		LE12	76.95	2.28		LE1	77.71	2.46
	DR1	209.07	45.91		DR12	197.15	57.69		DR1	184.64	52.95
	HE11	6.90	0.73		HE12	7.59	1.02		HE1	7.63	1.04
	UN1	4.16	2.64		UN12	2.53	0.91		UN1	2.14	1.25
4(12)	PH11	70.24	8.38	4(11)	PH12	72.87	4.83	4(6)	PH1	71.65	5.08
	LE11	81.27	0.79		LE12	81.42	0.86		LE1	81.98	0.67
	DR1	110.04	16.18		DR12	108.19	18.03		DR1	98.47	18.19
	HE11	8.42	1.02		HE12	8.43	0.93		HE1	8.13	1.16
	UN1	2.72	2.40		UN12	2.85	2.53		UN1	4.98	2.76
1(14)	PH14	73.77	4.92	3(8)	PH14	67.49	10.41	1(13)	PH1	72.59	4.44
	LE14	81.91	0.79		LE14	81.70	1.35		LE1	81.78	0.79
	DR1	100.91	12.03		DR14	109.04	22.00		DR1	99.38	12.80
	HE14	10.26	0.85		HE201	7.98	0.97		HE1	10.36	0.82
	UN1	1.68	1.08		UN14	4.08	3.60		UN1	1.31	1.20
2(5)	PH14	58.16	8.35	4(4)	PH14	56.30	10.00	2(9)	PH1	57.19	9.17
	LE14	76.02	1.46		LE14	76.18	1.67		LE1	76.06	1.38
	DR1	213.28	30.00		DR14	195.75	40.45		DR1	204.07	33.71
	HE14	7.15	0.84		HE14	5.74	0.59		HE1	6.59	0.93
	UN1	3.44	1.36		UN14	10.35	2.03		UN1	5.78	3.85
								3(9)	PH1	69.12	11.09
									LE1	81.43	1.21
									DR1	105.38	22.24
									HE1	7.85	0.98
									UN1	3.67	3.89

Source: Eurostat (2019); own calculation.

In each year, the mean value of the PH indicator was the highest in cluster 1. It is also the case for the LE indicator, except for the years 2012 and 2013, when slightly higher values of LE were exhibited in cluster 4. In 2014, the mean value of LE in cluster 1 exceeded that of cluster 4 significantly. In 2015, when only three clusters were created, the mean value of cluster 1 exceeded that of cluster 3 only very slightly. Cluster 3 had the lowest mean values in the PH indicator in the first three years, cluster 4 in 2014 and cluster 2 in 2015. However, it is cluster 2 which has the lowest mean values of LE in each year. On the other hand, the highest mean values of DR were exhibited by cluster 2 in each year. The lowest values are in cluster 4 in 2011 and 2013 and cluster 1 in the remaining

years. For the UN indicator, the lowest mean values were in cluster 1 in all the years and the highest values were in cluster 2, except for 2014, when cluster 4 had the highest value. In each year, the mean value of the HE indicator was the highest in cluster 1 and the lowest in cluster 2, except for 2014, when the lowest value was in cluster 4.

In cluster 1, a relatively low variability measured by the StD indicator was often identified. It was never the highest among the clusters. The lowest values were not exhibited only for the LE indicator in 2011, the PH and UN indicators in 2012, the PH and LE indicators in 2013 and finally, the HE indicator in 2014. Except for the LE indicator in 2011, the UN indicator in 2012 and the HE indicator in 2014, this variability was the second lowest. For the PH indicator, the highest variability was in cluster 2 (2011 – 2013) and cluster 3 (2014, 2015). For the LE and DR indicator, the StD values were the highest in cluster 3, except for 2014 (cluster 4) and 2015 (cluster 2). In the case of the UN indicator, the highest variability was in cluster 2 in 2011, cluster 4 in 2012 and 2013, and cluster 3 in 2014 and 2015. The highest variability in the HE indicator was in cluster 2 in the first two years, in cluster 4 in 2013, and in cluster 3 in the last two years. Following the explanation of the descriptive statistics, typical features of the clusters created can be derived based on Tables 2 and 4 as well as Figures 1 and 2. The changes can be justified as well.

All the core cluster 1 countries had high values of HE. These countries, along with Ireland, had the nine highest ranking HE values in the sample in the first three years. However, in Ireland the HE indicator has been decreasing annually since 2013. In 2015, the highest decrease in the sample (–2.24 p.p.) occurred and this country shifted into cluster 3. The five cluster 4 – 1 countries also had relatively high values of HE. All these five countries increased their HE levels. The UK showed the highest increase in the sample in 2013 and simultaneously entered cluster 1 this year. In Spain, the lowest increase in the sample in the whole period occurred. This country ended up with the lowest HE in the group of cluster 1 and cluster 4 – 1 countries in 2015. The ratio of Ireland was already significantly lower in this year. The second highest increase in Norway clearly shifted this country into cluster 1, while in 2015 this country surpassed not only cluster 4 – 1 countries, but also Belgium. In 2015, the ratio of Switzerland was the highest in the sample. It experienced the third highest increase in the monitored period and surpassed France, whose HE values were the highest in the previous years. Romania followed by Latvia had the lowest HE ratios in each year. Bulgaria had significantly higher values in each year. Moreover, in 2014, Bulgaria had the highest annual decrease of this ratio in the sample (0.66 p.p.) and the other two countries shifted into cluster 4 in that year. Accordingly, in 2014 cluster 4 had

the lowest mean values rather than cluster 2. Two cluster 3 – 2 – 4 – 2 countries and Lithuania had one of the lowest HE values in each year as well. Those of the other three cluster 3 – 2 countries were slightly higher. Czechia exceeded these three countries from 2013. As regards the cluster 4 – 3 countries, the values were more widely distributed, with the lowest values in Luxembourg followed by Cyprus and the highest in Portugal in 2011 – 2014 and Italy in the last year. The HE indicator significantly determined the classification of countries into the clusters. Apart from the cluster 4 – 3 countries, the other countries are clearly divided into the groups according to their ratios of expenditures to GDP.

As regards the objective indicators, their values are more widely distributed in the core cluster 1 countries. Switzerland exhibited the highest values of LE in the sample, except for 2012, when it was surpassed by Iceland and 2013, when it was surpassed by Spain. The values of Denmark are only medium and lowest in this group, but in 2015, this country surpassed Germany, which had a very slight increase in the monitored period (see subsection 3.1). France was the second-best performing core cluster 1 country, but there are several cluster 4 – 1 and 4 – 3 countries, which had higher LE values. Switzerland also exhibited the lowest DR in the majority of years. It was surpassed by Cyprus in 2011 and Iceland in 2013. Sweden is the second-best performing core cluster 1 country. In the bottom part of the LE ranking, the core cluster 2 countries, cluster 3 – 2 countries and cluster 3 – 2 – 4 – 2 countries can be found. Lithuania was the worst performing country, except for 2012 and 2014, when the lowest LE was exhibited by Latvia and Bulgaria respectively. Overall, the values above average levels, which can be best represented by those of Germany and Denmark,[3] are those of cluster 1, 4 – 1, 4 – 3 countries and Ireland. As regards the values below the average, the core cluster 3 country, Czechia, is the best performing country and then two cluster 3 – 2 – 4 – 2 countries, Croatia and other cluster 3 – 2 and cluster 2 countries follow (with small modifications between the years). All four cluster 3 – 2 countries exhibited decreased LE values in 2015 after increases had occurred in previous years. This applies to DR in the reversed order as well. However, Hungary exhibited the highest DR in each year, Lithuania followed it in the majority of years. The other cluster 2, cluster 3 – 2, cluster 3 – 2 – 4 – 2, Czechia, Slovenia and Greece follow. Subsequently, the remaining cluster 1, 4 – 1 and 4 – 3 had relatively low DR values.

Regarding the subjective indicators, the values for the PH and UN indicator seem to be reversed to some extent as well. The most significant difference in the distribution of the values of these indicators is that the values of cluster 4 – 3

[3] Some of the values of these countries (especially Slovenia in all three years) are higher than that of Denmark and lower than that of Germany in the first three years.

countries are distributed across the whole sample. Ireland had the highest PH in the sample in all the years. It was followed by Switzerland and Sweden in the first three years. In 2014, Norway exceeded Switzerland and in 2015, Cyprus surpassed all these three countries.

The majority of cluster 1, cluster 4 – 1 and several cluster 4 – 3 countries, especially Cyprus, Iceland, Greece and Luxembourg, followed or had relatively high values. However, Romania was the best performing country among the cluster 2, 3, 3 – 2, and 3 – 2 – 4 – 2, even exceeding some cluster 1 countries (Germany in each year; France – except for 2012, Austria – in 2013 and 2015), cluster 4 – 1 countries (Finland – except for 2011 and 2014; the UK in the last year) and cluster 4 – 3 countries (Italy (except for 2012), Slovenia and Portugal). Bulgaria also exceeded Germany, Slovenia and Portugal in each year. The values of Latvia were the second lowest in almost each year, except for 2013, when the value was even the lowest in the sample. In the remaining years, Lithuania had the lowest values. Besides these two countries, Portugal, Estonia, Hungary, Poland and Croatia had one of the lowest values.

Concerning the UN indicator, the highest values of Latvia, followed by Romania and Bulgaria can be seen in 2011. Latvia was the worst performing country in all the years, except for 2015, when it was surpassed by Estonia and Greece, in which the highest increases occurred, as well as Romania. Latvia followed by Bulgaria had the highest decreases. This led to a more substantial improvement in Bulgaria's ranking in particular. Cluster 3 – 2 – 4 – 2 also had among the worst results. This is also the case of Greece, Italy, Finland and even Iceland. In Finland, the value of the UN indicator decreased significantly only in 2014, when it entered cluster 1, but in 2015, it increased again. Cyprus had also relatively high values, but in 2015, the second highest drop in the sample occurred. Slovenia had the lowest values of the UN indicator in the first three years and Austria in the second two years. The core cluster 1 countries exhibited low (especially the Netherlands) and medium values, with the highest among them shown by France in the first four years and Belgium in 2015. The cluster 4 – 1 countries had relatively low values, except for Finland in each year and the UK in the last year. As regards the cluster 4 – 3 countries, besides Slovenia, low values were also in Luxembourg and Czechia, which is a core cluster 3 country.

3.3. Detailed Analysis and Discussion

For the overall assessment, the classification into five clusters according to all the indicator values was used. These assignments are shown in Table 5 (resulting from the last dendogram displayed in Figure 1). The rationale behind this assignment can be clearly seen in Figure 2 based on the PCA.

T a b l e 5

Assignment to Clusters According to the Indicator Values of the Period 2011 – 2015

AT	BE	DK	FR	DE	IR	MT	NL	NO	ES	SE	CH	UK	BG	EE	LT
1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2
PL	**RO**	**HR**	**CZ**	**PT**	**SK**	**SL**	**CY**	**FI**	**GR**	**IS**	**IT**	**LU**	**HU**	**LV**	
2	2	3	3	3	3	3	4	4	4	4	4	4	5	5	

Source: Own elaboration.

In cluster 1, not only the core cluster 1 countries, but also Ireland, Malta, Norway, Spain and the UK are included. This means that four cluster 4 – 1 countries formed a common cluster with the core cluster 1 countries. Only Finland, which shifted to cluster 1 last, remained a cluster 4 country by all indicator values. Cluster 2 contains three core countries, although two of them were included in cluster 4 in 2014. Moreover, two 3 – 2 – 4 – 2 cluster countries – Estonia and Poland, ended up in this cluster. Czechia, the only core cluster 3 country, is in cluster 3 along with Croatia, Slovakia, Portugal and Slovenia. The first two of those four are cluster 3 – 2 countries and the second two are cluster 4 – 3 countries which were in cluster 4 for the fewest number of years. In cluster 4, three small countries, two Southern countries – Greece and Italy, and one Northern country – Finland, are included. Only two countries are included in cluster 5 using all the indicator values. These are the remaining cluster 3 – 2 countries – Hungary and Lithuania. Although Croatia and Slovakia experienced the same development, they were assigned to cluster 3 according to all the indicator values. Figure 2 clearly shows the shifts of these countries and confirms that the countries of particular groups are close to one another.

For each indicator there is a clear boundary dividing two groups of countries which are often, but not always, determined by which cluster they are in. For the PH indicator, the majority of cluster 1 and 4 countries are on one side of the boundary, and most cluster 2 and 3 countries are on the other. The first group exhibited relatively high and the second group relatively low values. Romania is on the cluster 1 and 4 side of this boundary every year and Bulgaria is close to that line. On the other hand, Germany and Italy had lower values in each year than those achieved by the majority of countries in the first group. This is also the case for Finland in 2012 and 2013. For the UN indicator there is a clearly defined boundary between cluster 1 countries, which had low values, and the majority of countries from the other groups, which often had relatively high values. However, Slovenia, Luxembourg, Czechia and Slovakia are on the cluster 1 side of this boundary every year, as are Portugal in 2011, Hungary in 2014 and Croatia and Cyprus in 2015. For this indicator, the values of two cluster 5 countries are close to the boundary. Ireland was on the cluster 2, 3 and 5 side, except for

2011, when it had the same value as Slovakia. The UK and Belgium were on this side in the last year and France in some years as well. For the objective indicators and the HE indicator, there is a clearly defined boundary between cluster 1 and 4 countries on the one hand and the other groups on the other hand. For the LE indicator, the values of Slovenia and Portugal were above the borderline (relatively high) and for the DR indicator, only Portugal's values are below the borderline. However, Slovenia is close to this line. For the HE indicators, the highest values are those of cluster 1 countries. Cyprus and Luxembourg are the main representatives of cluster 4 countries, whose HE ratios are below the boundary. Greece and Iceland were close to that line, except for Greece in 2011, when its values were higher. Portugal and Slovenia are cluster 3 countries, which are on the cluster 1 and 4 side in each year. Moreover, Bulgaria as a cluster 2 country was close to that boundary in each year and surpassed it in the last year.

When compared with Drastichová and Filzmoser (2019), in this study more changes occurred and more changes are similar in certain groups of countries, and these groups often consist of countries with more significant differences. This means that while in the previous study, the Northern and other more developed countries, the Southern countries, and the least developed countries often formed common clusters, in this paper the groups were not so homogenous. The core cluster 2 countries were the same, but in the previous study, all three countries remained in cluster 2 in the whole period. Ireland is a country that experienced reversed development, i.e. form cluster 1 to cluster 3 in this paper, while in the previous study, it ended up in cluster 1 with the most developed countries. In Drastichová (2019), the countries were predominantly assigned to clusters according to types of health system. A moderate negative correlation between GDP per capita/the overall CHE ratio and DR was identified in this study, while there was a moderate positive correlation between GDP per capita/the overall CHE ratio and LE. What's more, it was much smaller (or not existent) between the first two indicators and the qualitative indicators reflecting health outcomes. Several similarities and differences between countries discovered in that study are confirmed in this paper (e.g. between Finland and the UK).

It can be confirmed that the evidence for a causal link between healthcare expenditure and health outcomes remains elusive as problems emerge from the difficulty of isolating the contribution of the health service input as a determinant of health status output (Goldacre, 1996). In this work a number of relationships were discovered between health inputs and outcomes, expressed by both objective and subjective indicators, by means of HCA, PCA and simple correlation analysis. According to the correlation coefficients, stronger relationships exist between HE ratios (inputs) and the objective indicators reflecting health

outcomes than between HE ratios and the subjective indicators used in this analysis. Using HCA and PCA, the results are not straightforward, but generally, the relationships between HE ratios and the applied indicators reflecting health outcomes were confirmed. The mean values of HE ratios are the highest in cluster 1 and the lowest in cluster 2 (except for 2014, when cluster 4 had the lowest ratio). The mean values of UN and DR were the lowest in cluster 1 (except for DR in 2011 and 2013, when slightly lower values were in cluster 4) and the highest in cluster 2 (except for UN in 2014). The highest LE (except for 2012 and 2013, when slightly lower values are in cluster 4) and PH were in cluster 1 and the lowest LE in cluster 2. The lowest PH was exhibited in cluster 2 only in 2015. Based on these results, it is not straightforward whether the objective or subjective indicators have more significant relationships with HE ratios. Rather, it can be concluded that certain relationships prevail in particular clusters.

Conclusions

The aim of this paper was to cluster the sample of 31 countries in accordance with their performance in the indicators of the social pillar of SD reflecting health inputs and outcomes, and to evaluate their development in relation to SD. The HCA and PCA were applied as main methods. The performance of the 28 EU countries was evaluated and compared with three non-EU countries included in the sample, which are Iceland, Norway and Switzerland. Two pairs of indicators were chosen, where the first pair includes the objective indicators – the DR and LE indicators, and the second includes the subjective indicators – the UN and PH indicators. The fifth indicator – the HE ratio (percentage of GDP) represented the resources dedicated to health functions. The groups of countries with similar indicator values were formed for each year of the period 2011 – 2015 as well as for the whole period. Four clusters were created in the years 2011 – 2014, three clusters in 2015 and five clusters for the overall period. Certain patterns were discovered in relationships between the indicators used in particular clusters, rather than straightforward relationships between HE ratios (resources) on the one hand and subjective and objective indicators reflecting health outcomes on the other hand.

Based on all the indicator values in all the years, cluster 1 includes thirteen countries, namely two Benelux countries, three Northern countries, Austria, Germany, France, Malta, Switzerland, the UK, Ireland, and one Southern country, Spain. Cluster 4 contains the remaining Northern countries and Southern countries – Finland, Iceland, Greece and Italy, along with another two small countries – Cyprus and Luxembourg. In cluster 3, Czechia, Croatia, Slovenia, Slovakia

and Portugal are included. The less developed EU countries having low performance are included in cluster 2 (Bulgaria, Romania, Latvia, Estonia and Poland) and cluster 5 (Hungary and Lithuania).

In the first two groups, the countries with the best results and relatively good results in both objective and subjective indicators can be found. The highest average HE ratios are exhibited by cluster 1 in each year. In cluster 4, they are the second highest, except for 2011, when cluster 3 had a slightly higher average ratio. In each year, the differences between their ratios are very small. When compared cluster 1 and 4, cluster 1 had better average results in the subjective and cluster 4 in the objective indicators. Although the HE ratios correlated more significantly with the objective indicators in the whole sample, cluster 1 had the highest average HE ratios and achieved the best results for the subjective indicators. Cluster 3 even had lower average values of the UN indicator than cluster 4 in each year. However, it had slightly lower average PH values than cluster 2 in the first three years. Their values are very similar in each year. Cluster 5 exhibited higher average performance than cluster 2 only in the UN indicator and its average HE ratios were also higher. However, this is especially due to higher ratios of Hungary. Therefore, Lithuania can be evaluated as the worst performing country of the sample, exhibiting among the worst performances in almost all the indicators included, apart from the UN indicator. Accordingly, it can also be confirmed that good results in subjective indicators can also be achieved by countries exhibiting the lowest performance in the objective indicators. Overall, clusters 1 and 4 are evaluated as the best performing clusters; cluster 3 exhibited the second highest performance and cluster 2 and 5 had the lowest performance.

Greece and Ireland have exhibited significant decreases in their HE ratios and both of the subjective indicators exhibited an unfavourable development. Similar features of development in these variables were seen in the country which had the worst performance, i.e. Lithuania. This indicates a shift towards higher unsustainability, which was more serious in Greece. A significant shift from the group of cluster 1 and 4 countries occurred. On the other hand, two cluster 3 countries – Slovenia and Czechia have experienced great shift towards this groups. Although Portugal and Slovakia are close to these countries, the direction of development seems to have reversed towards cluster 2 countries, especially in Slovakia. The last cluster 3 country according to all indicator values, Croatia, has exhibited a significant shift towards the group of cluster 1 and 4 countries, although in the more recent period the trend seems to have reversed towards cluster 2 or even cluster 5 countries as well. The problematic aspect in Croatia, Slovakia and Portugal could be the significant decrease in their HE ratios. Only in Portugal, the subjective indicators also exhibited an unfavourable development. As indicated,

Slovakia and Croatia ended up in cluster 2 again, as they were finally closer to them from 2014. Accordingly, the development in Czechia can be evaluated as leading towards higher sustainability, because Slovenia exhibited a slight decrease in the HE ratio and a slight increase in the UN indicator. As regards two clusters with the lowest performance, the significant progress in all the indicator values occurred in Romania, Latvia (two core cluster 2 countries), but they are still far from the developed countries. Despite the highest increase in the HE ratio in Bulgaria, its DR indicator exhibited the second highest increase in the sample and its PH indicator declined as well. The second cluster 5 country, Hungary, and the remaining cluster 2 countries, Poland and Estonia (referred to as 3 – 2 – 4 – 2 countries), are not only far from the developed countries, but several negative trends of development occurred as well (Estonia: the negative development in the subjective indicators; Hungary: a high decrease in the HE ratio).

The analysis of the individual years helped understand the development of countries in the monitored period and how close were countries to one another. This can also show the signs of their future development. There were eight core cluster 1 countries and four cluster 1 countries according to the overall assessment – Malta, Norway, Spain and the UK, shifted there from cluster 4. All these countries, referred to as cluster 4 – 1 countries, exhibited increases in their HE ratios, while those of the UK and Norway were the highest in the sample. Although Finland exhibited favourable development in all indicators, including a significant increase in its HE ratio, its UN values are still relatively high and it is a cluster 4 country according to all indicator values. The countries referred to as cluster 4 – 3 countries shifted from cluster 4 to cluster 3. They include the small countries – Luxembourg, Iceland and Cyprus, three Southern countries – Greece, Italy and Portugal, as well as Slovenia. Apart from Slovenia and Portugal, which were assigned to cluster 4 for the lowest numbers of years, all the remaining countries are cluster 4 countries according to all indicator values. Another two groups of countries, which were close to one another and experienced the same development between clusters, are cluster 3 – 2 (Slovakia, Croatia, Lithuania and Hungary) and cluster 3 – 2 – 4 – 2 countries (Estonia and Poland). As indicated in the previous paragraph, cluster 3 – 2 countries are clearly divided into two pairs, as the first two are close together in cluster 3 and the second two in cluster 5 when an evaluation by all indicator values is applied. All the non-EU countries had a relatively high performance, while Switzerland can be evaluated as the best performing country in the sample.

Less developed EU countries should focus on improving values for the monitored indicators reflecting health outcomes, which would require the enhancement of many aspects of their health care systems, including the provision of

sufficient levels of expenditure. A great challenge for the future is to improve the methodology of measurement the relationship between health inputs and health outcomes as well as the indicators reflecting health outcomes. This is also crucial for policies aiming at efficiency and sustainability of health care systems. It is an important part of SD and strategies for achieving SD.

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