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Analysis of the Sustainable Development Indicators in the OECD Countries

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Received: 29 October 2018; Accepted: 28 November 2018; Published: 3 December 2018

Abstract: Sustainable development is a key task for governments that should end poverty, ensure prosperity, create better conditions for health, education or social needs. The set of indicators to be monitored for evaluation of successes or failures of the sustainable development varies by intergovernmental organizations like OECD or EU. To discover the status and dynamics of variables which are part of the sustainable development goals of the OECD countries is the main aim of the presented analysis. To measure the convergence of socio-economic indicators the coefficient of variation was used. The Pearson's correlations coefficient and regression analysis were applied to detect the linear relationship between a pair of variables. The OECD countries were compared not only by using univariate statistical methods but also by applying a multivariate approach. The cluster analysis and principal component analysis were used for a set of indicators to monitor the countries from a wider perspective. The analyzed indicators GDP per capita or real change in GDP per capita belong to variables of economic activity. Variables of life expectancy at birth, standardized death rates for noncommunicable diseases belong to indicators of health. Altogether fifteen selected indicators were used for a multivariate analysis of OECD countries in two periods of time.

Keywords: expenditure on health per capita; gross domestic product; life expectancy; death rates; convergence; cluster analysis; sustainability; OECD countries

1. Introduction

The sustainable development belongs to the main goals and policies of societies all over the world. The 2030 Agenda for Sustainable Development that was adopted by the international community in September 2015 represents a set of goals to end poverty, protect the planet and ensure prosperity for all [1,2].

For the United Nations and the countries, it took several decades to reach this new and very ambitious Agenda 2030. In 1992 at the Earth Summit, Agenda 21 was adopted. Agenda 21, the Rio Declaration on Environment and Development, is a comprehensive plan of action to be taken in every area in which human impacts on the environment. It is a global partnership for sustainable development to improve human lives and protect the environment [3]. In the same year the Commission on Sustainable Development (SD) was established to monitor, report and ensure the implementation of the agreements of the Rio Declaration.

The new Millennium brings new pretentious aims for the UN countries. The aims were summarized in the Millennium Declaration that the Member States adopted in the year 2000. The eight Millennium Development Goals include targets for: Reduction of extreme poverty and hunger, achievements of universal primary education, promotion of gender equality, reduction of children mortality, improvement of maternal health, halting the spread of HIV/AIDS, malaria and other diseases, ensuring environmental sustainability and securing global partnership for

development by 2015 [4]. Ten years after the Rio Earth Summit the World Summit on SD held in Johannesburg in 2002 reaffirmed the commitments to the reduction of poverty and environment protection. The Johannesburg Summit 2002 brought attention and action toward improving people's lives, protecting natural resources in a world with a growing population [5].

The UN Member States decided to launch a process to develop a set of Sustainable Development Goals (SDGs) in Rio in 2012, during the Conference on SD (Rio+20 conference). In Rio the Member States renewed the commitment to SD and guaranteed promotion of an economically, socially and environmentally sustainable future for the planet and for the present and future generations in the Resolution: "The future we want" [6]. In 2013 an Open Working Group was set up by the General Assembly with an ambitious objective to develop a proposal on the SDGs. The SDGs were built upon the Millennium Goals. The negotiation process on the post-2015 development agenda culminated in the adoption of the 2030 Agenda for Sustainable Development with 17 SDGs and 169 associated targets at the United Nations SD Summit in September 2015 in New York [1,2].

The implementation of the 2030 Agenda brings benefits for all, for today's generation and for future generations, for planet and prosperity, it seeks to strengthen peace and freedom. The benefits from the performance of the SDGs over the next fifteen years should be notable for [1]:

- People through ending poverty and hunger;
- Planet by protecting the planet from degradation, sustainable management of its natural resources and by taking urgent actions on climate change;
- Prosperity by ensuring of prosperous and fulfilling lives for all human beings;
- Peace by determining to foster peaceful, just and inclusive societies free from fear and violence;
- Partnership by finding the means required to implement the Agenda through Global Partnership for SD.

The core of the 2030 Agenda are the seventeen Sustainable Development Goals (SDGs) and associated targets to be achieved over the next 15 years. The SDGs are the most salient points for understanding and achieving environmental and human development ambitions up to the year 2030 [7], they recognize that ending poverty must be associate with strategies for sustainable economic growth, for including wide range of social needs, like health, education, social protection, job opportunities, protection of environment and tackling climate change [2,3].The SDGs are not legally binding, but the governments are expected to take ownership and establish national frameworks for the achievement of the following seventeen goals [8]:

1. No poverty;
2. Zero hunger;
3. Good health and well-being;
4. Quality education;
5. Gender equality;
6. Clean water and sanitation;
7. Affordable and clean energy;
8. Decent work and economic growth;
9. Industry, innovation and infrastructure;
10. Reduced inequalities;
11. Sustainable cities and communities;
12. Responsible consumption and production;
13. Climate action;
14. Life bellow water;
15. Life on land;
16. Peace, justice and strong institutions;
17. Partnership for the goals.

As the SDGs are universally applicable to all countries the EU, OECD and other international organizations are committed to being the frontrunners in implement the SDGs into their policies [9,10]. OECD and also the EU developed a special indicator set to monitor the SDGs in the OECD framework [11] and the EU framework [12–14]. OECD will support countries for identification of the current stand in relation to the SDGs and it will propose sustainable pathways based on evidence [15]. Among the strategies of the OECD toward the 2030 Agenda is the improving policy coherence through a variety of projects and initiatives. Promoting investment in SD will be the next ambitious strategy, new resources should be established for ensuring long term development and improvement of investment conditions. The next initiative should ensure the planet's sustainability and create a balance between socio-economic progress and the ecosystems [15,16].

The SDGs feature in 10 European Commission's priorities [17,18]: Jobs, growth and investment; digital single market; energy union and climate; internal market; a deeper and fairer economic and monetary union; a balanced and progressive trade policy to harness globalization; justice and fundamental rights; migration; a stronger global actor; democratic change. The strategies, instruments and actions contributing to the SDGs within the EU are in details presented in the Communication from the Commission: European action for sustainability [19]. The implementation and progress toward the SDGs are in the interest not only of the United Nations or other intergovernmental organizations, but it is in the interest of researchers all over the globe. Some very interesting research was conducted in the field of academic accounting and its role in furthering achievement of the SDGs through enhanced understanding, critiquing and advancing of accounting policy, practice and theorizing [7], while some other researchers analyzed the differences between the traditionally discrete domains of financial reporting and sustainability reporting [20], they discussed the adoption of corporate governance, environmental and social practices in order to react to unexpected shocks, while preserving business sustainability [21]. The last but not the least, was the original research on evaluation of the quality of non-financial information in two selected EU Member States before the implementation of the EU Non-financial reporting Directive that should increase the quality of sustainability reporting of the companies [22]. Further research on implementation and achievements in the field of the 2030 Agenda is very needed and perspective.

The main aim of the presented article and analysis is to discover the status and developments of the selected indicators in the OECD countries. The indicators are part of the SDGs. Using suitable statistical techniques (one-dimensional or multivariate approaches of analysis) it was possible to follow the changes of a solo indicator or to look at more than one variable and so to describe the status of the OECD countries.

2. Materials and Methods

The socio-economic indicators used for analyses of the status and development of the 35 OECD countries were downloaded from the OECD.Stat database [23]. The database is freely accessible and includes data and metadata for all OECD countries and also for some non-member economies.

For analysis of a solo indicator the univariate statistical approach was chosen [24,25]. A variable was characterized by its average level, minimum, maximum, standard deviation, median, first and third quartile. The analysis focused on the variability of the analyzed indicators. To compare the changes of variability in selected indicators the range is not always suitable because it measures the variability only through the maximal and the minimal values of an indicator. Much more suitable for comparison of a convergence in case of variability is a relative measure of variability, for example the coefficient of variation. The coefficient of variation (CV) belongs to the so-called sigma convergence coefficients [26,27] used to measure the convergence process of selected socio-economic variables. Convergence is an often-discussed issue not only on the country level but also on the regional levels [28–30]. To detect the linear relationship between a pair of indicators the correlation and regression analysis were used [24,25].

Besides a univariate statistical analytical approach, the contribution is devoted to the application of multidimensional methods in assessing the state of OECD countries. Among the multivariate statistical method, the cluster analysis and the principal component analysis were applied to a set of selected socio-economic indicators. The indicators used for multivariate or univariate analysis are part of the SDGs of the OECD countries. Cluster analysis is a very useful tool that tries to identify structures within the selected dataset. For grouping objects of similar kind into categories different algorithms and methods are used. These methods are often called a segmentation analysis that organizes selected data into meaningful structures, these methods do not make any distinction between independent or dependent variables [31,32]. Cluster analysis (CA) tries to sort different objects (in our case different OECD countries). CA identifies homogenous groups of objects in a way, that the objects are similar to one another within the same cluster and dissimilar to the objects in other clusters. It means that we can expect that the degree of association between two objects is maximal if they belong to the same group and minimal otherwise [31–33]. Cluster analysis is a very useful technique that helps to organize observed date or cases into two or more homogenous groups and an advantage of this analysis is that it doesn't require any prior knowledge of which object belongs to which clusters. Different measures have been used to measure the distance for different data types and several different hierarchical or non-hierarchical methods are used to determine which clusters should be joined at each stage, for example nearest neighbor method, furthest neighbor method, average linkage method, centroid method, Ward's method, *k*-means clustering method [34,35].

For cluster analysis 35 OECD Member States were used as objects and a few socio-economic variables as indicators. The data for analysis comes from the OECD.Stat database [23]. The problem of data collinearity is a usual problem of multivariate statistical analysis. It is necessary to think about the best way how to solve the problem if the selected variables will be strongly correlated with each other. For this reason, a principal component analysis should be taken into consideration. Principal component analysis (PCA) belongs to a group of techniques that creates a smaller number of linear combinations of analyzed variables. The reduced "new" variables should account for and explain most of the variance in correlation matrix pattern [36,37]. PCA is a dimensionality reduction method. PCA helps the determine a minimum number of factors that will account for the maximum variance in the dataset in use. It means, that principal component analysis is a dimension-reduction tool that can be used to reduce a large set of variables to a smaller set of uncorrelated variables called principal components. PCA creates the same number of components as is the number of analyzed original variables but usually only a few of them are used for the next analysis, for example in our study for the cluster analysis technique. The first principal component accounts for the highest variability in the data and each subsequent component account for as much of the remaining variability as possible [37–39]. For the next analysis it is useful to take only the first m eigenvectors which explain a predetermined threshold of the total variability, for example the first m eigenvectors should in common explain at least 80% of the total variability of the original dataset. The next way is to check the scree plot of the PCA, which plots the variance explained by each of the components. The number of components to be used in the next analysis can be assessed from the scree plot by the inflection point of the principal components.

The principal component analysis is a very useful analytical technique for the reduction of the original dataset dimensions and for the creation of uncorrelated "new" dataset for the subsequent multivariate analysis.

3. Results

Gross domestic product is a measure for the economic activity, it measures the value of the total final output of goods and services produced by an economy within a certain period of time [40]. It is also used as a proxy for the development of a country's material living standards. GDP per capita is calculated as the ratio of GDP to the average population, it can be expressed in purchasing power parities (PPP), which represents a common currency that eliminates the differences in price an enables

a meaningful comparison of the GDP [40]. The limitations of the GDP are, that it does not monitor the environmental or social effects of economic activity [41].

GDP is in the interest of the Agenda 2030. The change in real GDP per capita belong to the Goal 8—Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all, while GDP per capita in PPP is a part of the EU indicators of the Goal 10—Reduce inequality within and among countries [12,13].

Not only the economic activity is in the focus of OECD countries. Health is in point of view of the population in each country. Health is the main aim of the Goal 3—Ensure healthy lives and promote well-being for all at all ages [1,2,8]. In the interest of the Goal 3 is the life expectancies at birth and the death rates of population. The selected indicators analyzed in the presented paper are a part of The Agenda 2030 for Sustainable Development.

3.1. Gross Domestic Product and Current Expenditure on Health per Capita

In OECD countries the living standard increased steadily. The GDP per capita in PPP current prices jumped from an average level of USD 23,616.5 to USD 42,429.2 (see Table 1). In 2000 only five Member States had the GDP per capita lower than $10,000, namely Latvia ($8013), Estonia ($9385), Turkey ($9426), Chile ($9524) and Mexico ($9974). On the other hand, in the same year the per capita GDP was higher than $30,000 in Ireland, the Netherland, Switzerland, the United States, Norway and in Luxembourg ($55,221). The average GDP per capita increased to approximately $42,429 in 2016. Mexico had in 2016 according to the GDP per capita figures ($18,583) the lowest living standard between the OECD Member States. Extremely high GDP per capita was typical for Switzerland ($62,898), Ireland ($72,772) and again Luxembourg ($105,768). Although the standard deviation of the GDP per capita increased from 2000 till 2016, the convergence of countries from the GDP per capita point of view should be measured using a relative rate of variability. The coefficient of variation (CV) is a suitable relative measure of a convergence process of living standard across countries [42,43]. The CV decreased from a level of 43% in 2000 to 38.8% in 2016. The decreasing relative variability is a good signal of a convergence process of the GDP per capita of the OECD population.

Table 1. GDP per capita in OECD countries (purchasing power parities (PPP), current prices).

Year	Mean	Std Dev	Minimum	Maximum	Lower Quartile	Median	Upper Quartile
2000	23616.5	10139.0	8012.9	55220.9	16150.9	26210.1	29265.2
2001	24606.0	10274.3	9053.8	55980.4	17581.7	27480.6	29725.4
2002	25596.8	10515.8	9207.9	58709.0	18182.4	28567.2	30854.8
2003	26247.9	10547.7	9490.8	59951.8	19410.4	28886.9	31999.7
2004	27859.1	11143.6	10753.5	64038.5	20793.8	29386.9	33659.8
2005	29221.1	11728.6	11773.0	68140.7	21907.3	30625.9	35165.3
2006	31805.1	12972.4	13504.0	77948.8	23725.9	32567.6	37458.6
2007	33777.0	13631.2	14131.6	83825.3	25695.8	34176.9	39442.0
2008	35097.9	14093.6	14743.3	86592.0	26631.5	35154.8	41283.0
2009	34010.5	13277.5	14398.0	82290.4	26496.3	34269.2	40713.4
2010	35165.4	13625.8	15143.3	85680.2	27361.0	35003.7	41918.5
2011	36768.4	14413.4	16366.3	91814.0	26141.1	35935.5	43755.1
2012	37520.5	14543.3	16957.7	91526.7	26454.2	37213.8	44724.9
2013	39071.7	15008.1	17225.0	95352.3	27899.5	39008.4	46742.9
2014	40197.0	15556.0	17973.3	101465.9	28806.2	39435.2	47057.9
2015	41573.5	16334.2	17894.2	104243.4	29687.7	40737.3	47998.6
2016	42429.2	16470.2	18582.8	105767.8	30612.4	41489.9	49810.3

Source: OECD.Stat database [23]—own calculations based on OECD database.

In OECD countries the relative measure of variability of per capita expenditure on health (in PPP, current prices) is higher compared to the CV of GDP/capita. In 2000 the CV of current expenditures on health per capita was as high as 55%. Also, in this case the variability began to decline after 2000 and the CV reached 50.7% in 2016. The average amount spent on health per capita increased from $1788 in 2000 to $3997 in 2016 (see Table 2). The health expenditure (HE) per capita in 2000 was lower than

USD 600 altogether in five countries, namely in Turkey ($425), Latvia ($437), Mexico ($484), Estonia ($486) and Poland ($564). In the same year, very high expenditure on health per capita was typical for countries which faced also a very high level of GDP per capita. So, for example in Switzerland the expenditure on health per capita stood at $3332, in Luxembourg $3405 and the United States $4559.

The ranking of the countries with the lowest or the highest HE per capita did not change a lot till 2016. Again, the highest expenses on health were reached in Luxembourg ($7463), Switzerland ($7919) and the United States. In the USA the expenditure on health per capita reached almost $10,000. Compared with other OECD countries it is an extremely high level of HE per capita. On the opposite side are the countries with the lowest expenses on health per capita in 2016, like Mexico ($1080), Turkey ($1088), Latvia ($1466), Poland ($1798).

Table 2. Current expenditure on health per capita in OECD countries (PPP, current prices).

Year	Mean	Std Dev	Minimum	Maximum	Lower Quartile	Median	Upper Quartile
2000	1788.2	984.4	425.3	4559.0	802.9	1780.7	2421.9
2001	1928.8	1047.5	448.0	4910.7	904.0	1944.3	2608.1
2002	2078.7	1134.9	469.7	5327.9	1034.4	2102.2	2742.5
2003	2195.8	1185.8	480.7	5737.3	1255.5	2198.8	2850.2
2004	2340.6	1255.3	534.3	6095.9	1261.9	2327.8	3020.0
2005	2469.3	1308.4	582.9	6444.6	1366.0	2463.7	3282.5
2006	2650.6	1375.5	701.7	6808.0	1429.2	2580.1	3453.8
2007	2796.4	1423.0	777.4	7161.5	1571.1	2723.8	3647.0
2008	3000.3	1500.0	836.8	7402.5	1667.0	2895.4	3926.1
2009	3152.1	1576.6	849.5	7679.0	1836.6	2998.6	4128.3
2010	3225.8	1616.5	872.5	7931.7	1951.1	3140.5	4237.7
2011	3342.0	1661.3	911.6	8144.8	2009.2	3211.2	4518.1
2012	3455.4	1744.3	916.8	8414.7	2041.6	3245.4	4683.5
2013	3631.8	1810.7	977.9	8616.4	2175.4	3707.4	4861.0
2014	3733.9	1874.0	1002.7	9035.5	2098.9	3890.6	5000.6
2015	3848.0	1927.1	996.6	9507.2	2210.1	3993.2	5100.0
2016	3997.0	2025.1	1080.3	9892.3	2187.1	4062.2	5227.3

Source: OECD.Stat database [23]—own calculations based on OECD database.

According to the finding that countries have a similar ranking position by both variables (GDP per capita and health expenditures per capita) makes it possible to thing about a linear relationship between these characteristics. In Figure 1 the association of these variables is presented. In 2016 the Pearson's correlation coefficient between both variables was very high and positive (r_{xy} = 0.83). It means that in countries with high GDP per capita we can expect a high level of expenditure per capita and vice versa. From the lowest values of both characteristics till a level of about $5600 in the case of HE and about $60,000 in the case of GDP per capita the countries tightly copy the linear regression line, but from these levels the deviation of the countries from the theoretical regression line is rifer, in 2016 it was the case of Ireland, Luxembourg, Switzerland and the United States. For Luxembourg, we would according to the regression line expect due to a very high GDP per capita level a higher per capita expenditure on health, and in the case of the USA, a lower health expenditure is expected according to the GDP figures. The high correlation coefficient and also the high determination index (R^2 = 0.69) between both variables indicate a strong linear association between expenditure on health and GDP per capita in OECD countries.

The next assumption was that the GDP per capita, as a very rough estimate of the overall country's productivity, will grow more strongly than the expenditure on health per capita. The expectation that productivity generates the growth of expenditure on health has not been confirmed. Almost in all OECD countries the increase of real GDP per capita was lower than the real change in HE per capita between 2000 and 2016 (see Figure 2). Most notable was the difference between both characteristics in Korea and Chile. In Korea the real GDP per capita increased in the selected time span by 69.7%, but the real expenditure on health per capita grow by 222.9% and so the difference between both growth rates hit 153.3 percentage points (p.p.). In Chile the gap was as high as 108.7 p.p. In six OECD countries the

difference between growth rates was higher than 50 p.p. but lower than 100 p.p., namely in United Kingdom (74 p.p.), Sweden (62.6 p.p.), Japan (58.4 p.p.), the Netherlands (55.2 p.p.), Slovakia (55 p.p.) and Estonia (51.4 p.p.). In only two countries the real GDP per capita growth trespassed the real health expenses per capita changes. In Iceland the GDP per capita increased by 32% while the health expenditures per capita increased more moderately by 27.5%, in Turkey the changes reached 76.4% and 68.2% respectively. Even in countries most affected by the economic crisis the health expenses per capita grows moderately. For example, in Greece where the real GDP per capita between 2000 and 2016 declined by 2.7% the health expenses increased by 9.7%. In Italy the decline of GDP per capita was more significant, it dropped by 5.3%, but the real health expenses per capita changed oppositely and grow by 11.6%.

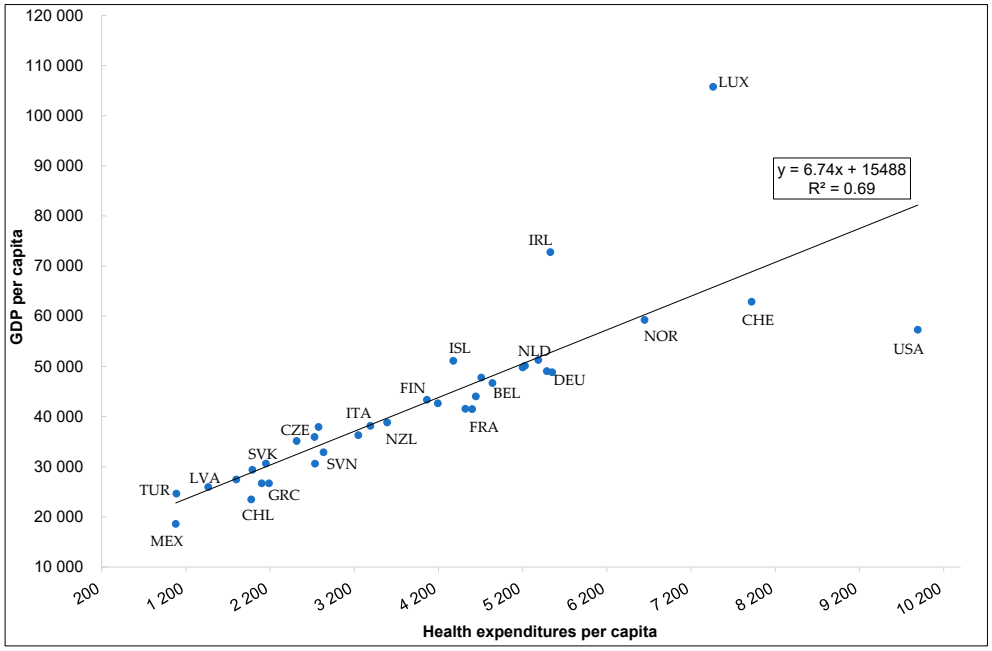

Figure 1. Association of expenditure on health per capita and GDP per capita in OECD countries in 2016 (per capita in PPP, USD, current prices, 2016). Source: OECD.Stat database [23]—own calculations based on OECD database. Country codes: AUS—Australia, AUT—Austria, BEL—Belgium, CAN—Canada, CHL—Chile, CZE—Czech Republic, DNK—Denmark, EST—Estonia, FIN—Finland, FRA—France, DEU—Germany, GRC—Greece, HUN—Hungary, ISL—Iceland, IRL—Ireland, IST—Israel, ITA—Italy, JPN—Japan, SO—Korea, LVA—Latvia, LUX—Luxembourg, MEX—Mexico, NLD—Netherlands, NZL—New Zealand, NOR—Norway, POL—Poland, PRT—Portugal, SVK—Slovakia, SVN—Slovenia, ESP—Spain, SWE—Sweden, CHE—Switzerland, TUR—Turkey, GBR—United Kingdom, USA—United States.

Strong increases of the health expenditures are visible also through an increase of the current health expenditures as a percent of GDP (see Figure 3). In the time span of selected years (2000 and 2016) the health expenditures as a share of GDP increased most significantly in the USA by 4.7 p.p. The USA had reached the highest shares of the health expenses between the OECD countries with 12.5% in 2000 and 17.2% in 2016. On the other hand, the smallest share was achieved in Turkey with a starting level of 4.6% in 2000 and with an ending ratio of 4.3% in 2016. The range between maximum and minimum increased from 8.5 p.p. in 2000 to 12.9 p.p. in 2016. While in 2000 only in one country (USA) the total health expenditures as a percent of GDP was higher than 10%, in 2016 it was a reality in 12 countries: Canada, Denmark, Austria, Belgium, Norway, the Netherlands, Japan, France, Sweden, Germany, Switzerland and USA. The threshold of 10% was overpassed in most developed OECD countries with a high living standard, high levels of GDP per capita, high life expectancies at birth.

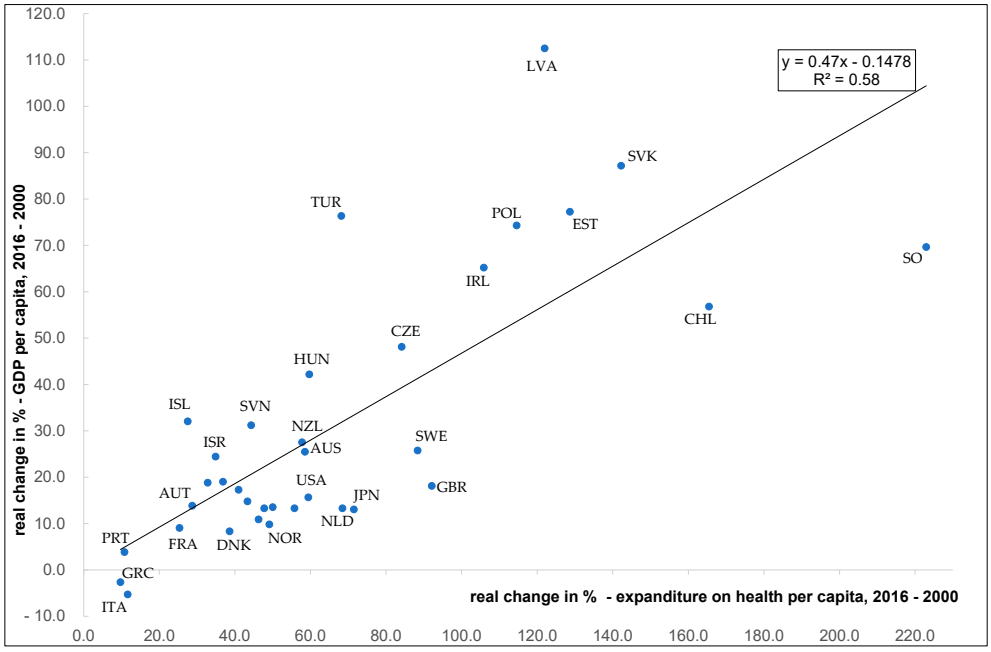

Figure 2. Real change in Expenditure on health per capita and GDP per capita in OECD countries between 2000 and 2016 in %. Source: OECD.Stat database [23]—own calculations based on OECD database.

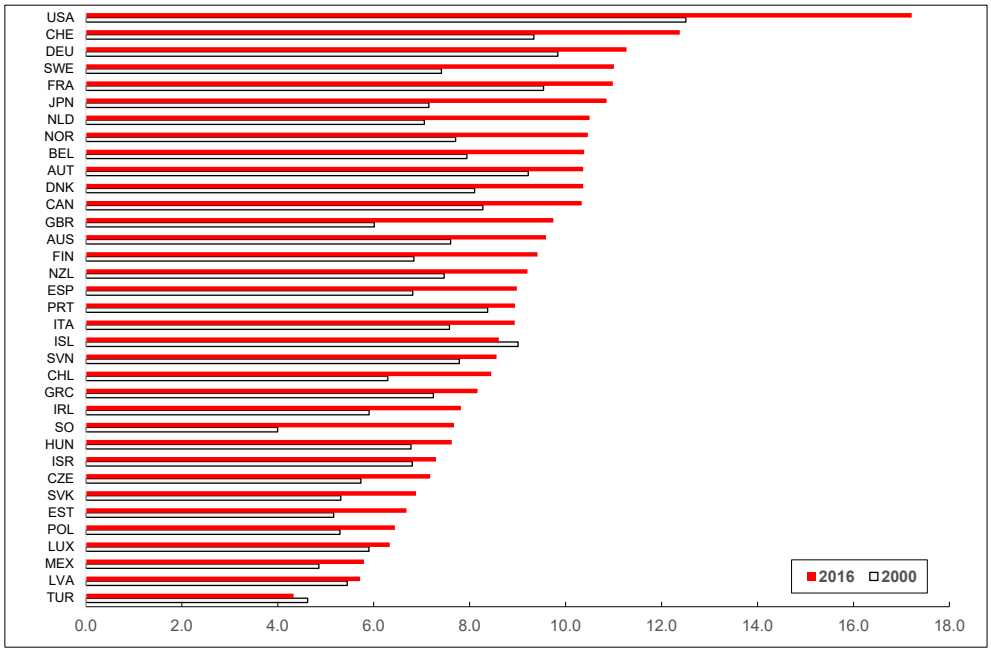

Figure 3. Current expenditure on health as a share of GDP in 2016 (in %). Source: OECD.Stat database [23]—own calculations based on OECD database.

Strong real growth of HE should positively affect the health outcome of the population in OECD countries. To discover the expected positive changes in health the following characteristics were chosen: Life expectancy (at birth and at the age 65), standardized death rates of noncommunicable diseases. Moreover, these variables were included in the multivariate analysis.

3.2. Life Expectancy at Birth and at Age 65

Life expectancy (LE) at birth refers to the mean number of years a new-born child can expect to live assuming that current mortality levels remain throughout his or her life constant [40]. LE at birth

belongs to the indicators of EU SDG indicator set for Goal 3 [12,13]. Live expectancies are very often used for international comparison of living standards, economic development in selected countries, they are used as an indicator of public health condition and status, they can explain the relation between the LE and pollution in selected areas [44,45]. Live expectancy (LE) is also calculated for specific ages and characterize the average number of years that a person at that age can be expected to live. To measure the success in declining mortality usually LE at a certain age is a very useful toll how to identify the progress of improved health care, changing living standards. For this purpose, the age 65 is a boundary that is generally accepted. LE at age 65 is the average number of years still to be lived by a person who has reached the age 65, if subjected throughout the rest of his or her life to the age-specific probabilities of dying [40].

Life expectancy at birth increased progressively in the OECD countries. The average LE for females was 73 years in 1970 and jumped to 83.2 in 2015. The LE for males was lower by 6.3 years compared to the life expectancies women in 1970 and stood at 66.7 years. The gap of LE at birth between both sexes is closing. In 2015 the difference between the average levels of LE between men and women was 5.2 years, the LE for men increased to 77.9 in 2015 (see Table 3). The correlation between LE for males and females is strong a positive. The box plot presentation of the women's LE at birth in Figure 4 identified four extreme values of LE for Turkey (56.3 years), Mexico (63.2), Chile (65.4) and Korea (65.8) in 1970. It is necessary to mention that in this year the data for Canada, Israel, Italy and Latvia were not available. Moreover, in the next decades one country had extremely low LE for women at birth, but positively can be considered the elimination of the extreme values. In 2015 no extreme LE for females was discovered. Not only women's LE at birth were, in some countries, extremely low, but the situation was, in some patterns, similar also for men. In 1970 altogether four countries had extremely low LE at birth for men: Turkey (52 years), Mexico (58.5), Korea (58.7), Chile (59.1). It is again necessary to mention that Canada, Israel, Italy and Latvia did not have any available data of LE for this period. In 2015 still in one country the LE at birth for men was extremely low compared to other OECD member states (Latvia; 69.7 years). While the minimum of LE at birth for females was typical for Turkey and Mexico (2015), the lowest LE at birth for men was only at the beginning reached in Turkey, later on the lowest values were typical for the former communist countries, Estonia and Latvia.

Table 3. Selected characteristics of life expectancy (LE) at birth in OECD countries.

LIFE EXPECTANCY AT BIRTH						
	1970	**1980**	**1990**	**2000**	**2010**	**2015**
MALES						
Minimum	52.0 *(Turkey)*	55.8 *(Turkey)*	64.7 *(Estonia)*	64.4 *(Latvia)*	67.9 *(Latvia)*	69.7 *(Latvia)*
Maximum	72.3 *(Sweden)*	73.5 *(Iceland)*	75.9 *(Japan)*	77.8 *(Iceland)*	80.3 *(Switzerland)*	81.2 *(Iceland)*
Average	**66.7**	**69.3**	**71.4**	**73.8**	**76.7**	**77.9**
FEMALES						
Minimum	56.3 *(Turkey)*	60.3 *(Turkey)*	69.5 *(Turkey)*	73.1 *(Turkey)*	76.8 *(Turkey)*	77.7 *(Mexico)*
Maximum	77.5 *(Norway)*	80.4 *(Iceland)*	81.9 *(Japan)*	84.6 *(Japan)*	86.3 *(Japan)*	87.1 *(Japan)*
Average	**73.0**	**76.0**	**78.1**	**80.1**	**82.4**	**83.2**
difference: average F - M	***6.3***	***6.7***	***6.7***	***6.3***	***5.7***	***5.3***

Source: OECD.Stat database [23]—own calculations based on OECD database.

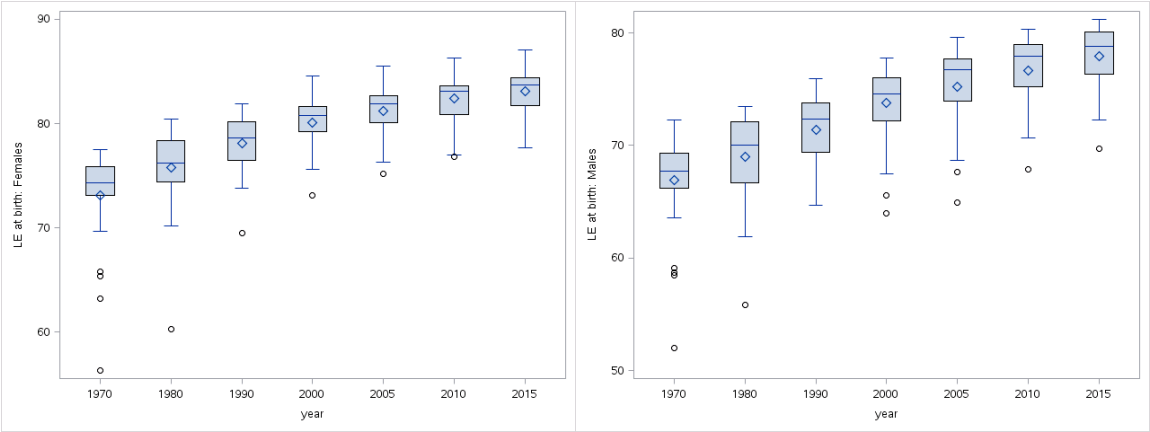

Figure 4. Box-plots of life expectancies at birth in OECD countries. Source: OECD.Stat database [23]—own calculations based on OECD database.

A very positive development was discovered for the LE at age 65. While the average LE at birth for women increased by about 14% and for man by 16.8%, the LE at age 65 increased more rapidly. Women in OECD countries at age 65 could expect to live another 21.1 years in 2015 compared with 15.6 years in 1970, which consists of an overall increase by about 35%. Men's LE at 65 in the same time span jumped by more than 40% from 12.7 years in 1970 to 17.9 years in 2015. One of the reasons for increasing spending on health per capita can be the increasing life expectancy, especially the LE at higher ages. The aging of the population is nowadays an issue that is often discussed from the perspective of the economic aspects of aging, the health care system, the expenditures for health care, and the sociological or psychological problems of the elderly population. Extreme values of LE at age 65 were not detected (see Figure 5) as often as in the case of the LE at birth. The lowest levels were typical for Turkey and Hungary in the case of women and in Korea or some former communist countries like the Czech Republic, Estonia, Latvia for men (see Table 4). On the other hand, high LE at age 65 was achieved for women in very developed countries like Sweden, Iceland, France, Japan and for men in Greece, Iceland, Switzerland and Australia.

Table 4. Selected characteristics of LE at age 65 in OECD countries.

LIFE EXPECTANCY AT AGE 65						
	1970	**1980**	**1990**	**2000**	**2010**	**2015**
MALES						
Minimum	10.2	10.6	11.7	12.7	13.1	14.2
	(Korea)	*(Korea)*	*(Czechia)*	*(Estonia)*	*(Latvia)*	*(Latvia)*
Maximum	15.0	15.7	16.4	17.8	19.0	19.5
	(Greece)	*(Iceland)*	*(Iceland)*	*(Iceland)*	*(Switzerland)*	*(Australia)*
Average	**12.7**	**13.3**	**14.3**	**15.6**	**17.2**	**17.9**
FEMALES						
Minimum	12.6	12.8	14.3	15.1	16.0	18.2
	(Turkey)	*(Turkey)*	*(Turkey)*	*(Turkey)*	*(Turkey)*	*(Hungary)*
Maximum	17.1	19.3	20.2	22.4	23.8	24.3
	(Sweden)	*(Iceland)*	*(France)*	*(Japan)*	*(Japan)*	*(Japan)*
Average	**15.6**	**16.8**	**17.9**	**19.1**	**20.7**	**21.1**
difference: average F - M	***2.9***	***3.5***	***3.6***	***3.5***	***3.5***	***3.2***

Source: OECD.Stat database [23]—own calculations based on OECD database.

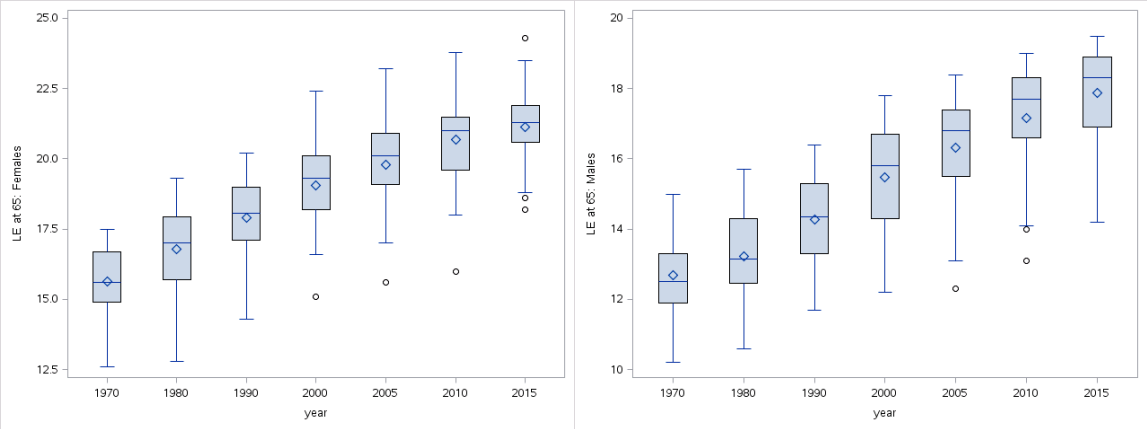

Figure 5. Box-plots of life expectancies at age 65 in OECD countries. Source: OECD.Stat database [23]—own calculations based on OECD database.

3.3. Clusters of OECD Countries

Multivariate analysis of the EU countries allows to include in the analysis not only a solo indicator but to select a few variables and to make an analysis with a group of the selected indicators. The first important issue is to appoint the set of variables. The researchers should pay enough attention to the selection procedure, as the outcome of the multivariate analysis will depend on the originally analyzed dataset. The main aim of a multivariate analysis was the creation of relatively good isolated groups of OECD countries, where the countries, characterized as objects, within a specific cluster are similar to each other and are dissimilar to the objects in different clusters. The multivariate analysis was carried out by professional statistical software SAS Enterprise Guide 6.1. For analytical purpose, some socio-economic indicators were chosen, some of the indicators are part of the new sustainability effort of the EU or the OECD [12,13,46]. The variables are taken for the latest available period, some of the indicators are available already for the year 2016, but some of them only for years 2013 or 2015. Some variables are identified separately for males and/or females and some variables are commonly used for the CA classified as total (standardized death rates). The commonly used indicators are also the expenditures for health care per inhabitant in PPS and the ratio of the total health care expenditures to GDP in percent, between some indicators we expect a strong linear association [47].

The OECD countries were grouped into clusters based on their similarity in two periods of time. For classification altogether 15 characteristics were used: Some indicators of economic situation in the countries, indicators of health expenditures, life expectancy at birth and standardized death rates of noncommunicable diseases. In the case of strong correlations between the selected indicators the most important principal components were used to carry out the CA instead of the original strongly correlated dataset. The principal components are linearly independent and so, they are suitable as input data for the cluster analysis method. Only the "most important" principle components were chosen to form the mutually isolated clusters of OECD countries; the optimal number of clusters was determined, using more ways of deciding [48–50].

The list of selected indicators used for the cluster analysis is as follows:

x_1 GDP per capita, in PPP, current prices,
x_2 Real change in GDP per capita in PPP,
x_3 Current expenditure on health per capita (all functions), in PPP, current prices,
x_4 Real change in Health expenditure per capita in PPP,
x_5 Health expenditures as % of GDP,
x_6 Government expenditure on health (compulsory schemes) as % of the current expenditure on health,
x_7 Household out-of-pocket payments on health as % of current expenditure on health,

x_8 Life expectancy at birth—females,
x_9 Life expectancy at birth—males,
x_{10} Standardized death rates—malignant neoplasms (MN),
x_{11} Standardized death rates—diabetes mellitus (DM),
x_{12} Standardized death rates—mental and behavioral disorders (MBD),
x_{13} Standardized death rates—diseases of the nervous system (NS),
x_{14} Standardized death rates—diseases of the circulatory system (CS),
x_{15} Standardized death rates—diseases of the respiratory system (RS).

3.3.1. Cluster Analysis—First Period

In the first period of cluster analysis the variables x_1, x_3, x_5–x_{15} represents the data from the beginning of the analyzed period, for year the 2000. To include the dynamics of GDP per capita and health expenditures per capita, the indicators x_2 and x_4 indicate the real change in both indicators between 2000 and 2008. Due to a strong correlation between some pairs of the variables presented in Table 5 the PCA was used for calculation of uncorrelated principals.

Table 5. Pearson's correlation coefficients (first period).

Variables	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{11}	x_{12}	x_{13}	x_{14}	x_{15}
x_1	1														
x_2	**-0.610**	1													
x_3	**0.897**	**-0.614**	1												
x_4	-0.527	**0.808**	**-0.621**	1											
x_5	0.520	-0.514	**0.824**	**-0.649**	1										
x_6	0.262	-0.091	0.106	-0.118	0.011	1									
x_7	-0.489	0.293	-0.474	0.256	-0.395	**-0.768**	1								
x_8	**0.644**	**-0.608**	**0.612**	-0.545	0.522	0.279	-0.336	1							
x_9	**0.696**	**-0.800**	**0.667**	**-0.647**	0.534	0.222	-0.344	**0.879**	1						
x_{10}	0.037	0.207	0.027	0.187	0.096	0.427	-0.416	0.042	-0.133	1					
x_{11}	-0.294	-0.200	-0.267	-0.130	-0.231	-0.530	0.501	-0.350	-0.137	-0.478	1				
x_{12}	0.414	-0.308	0.320	-0.173	0.097	-0.044	-0.085	0.284	0.385	-0.220	-0.048	1			
x_{13}	0.532	-0.422	**0.623**	-0.457	0.532	-0.017	-0.282	0.282	0.445	-0.074	-0.105	0.560	1		
x_{14}	-0.430	**0.752**	-0.390	0.557	-0.236	0.163	0.024	-0.474	**-0.697**	0.596	-0.329	-0.488	-0.402	1	
x_{15}	0.118	-0.312	0.005	0.107	-0.111	-0.053	-0.083	0.055	0.229	-0.053	0.127	0.184	0.039	-0.339	1

Source: OECD.Stat database [23]—own calculations based on OECD database.

For CA only the first five most important principals were used, these five principal components explain about 84% (see Figure 6) of the variation of the original dataset.

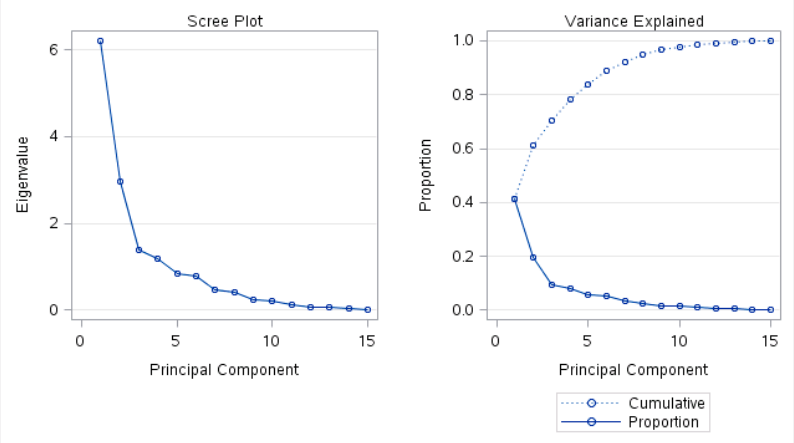

Figure 6. Scree plot of principal component analysis—first period. Source: OECD.Stat database [23]—own calculations based on OECD database.

In the first period of CA according to the cluster tree (Figure 7) the 35 OECD countries were split into five relatively isolated clusters. The created clusters separated 15 most developed countries into one larger cluster and another smaller cluster with eight countries. On the other hand, the less developed OECD countries were classified into a cluster with four objects, the East-European (former communist countries) were separated into a cluster with six objects. One cluster content only two countries (Ireland and the United Kingdom), these countries are similar not only due to the analyzed indicators but are also geographically very closely located.

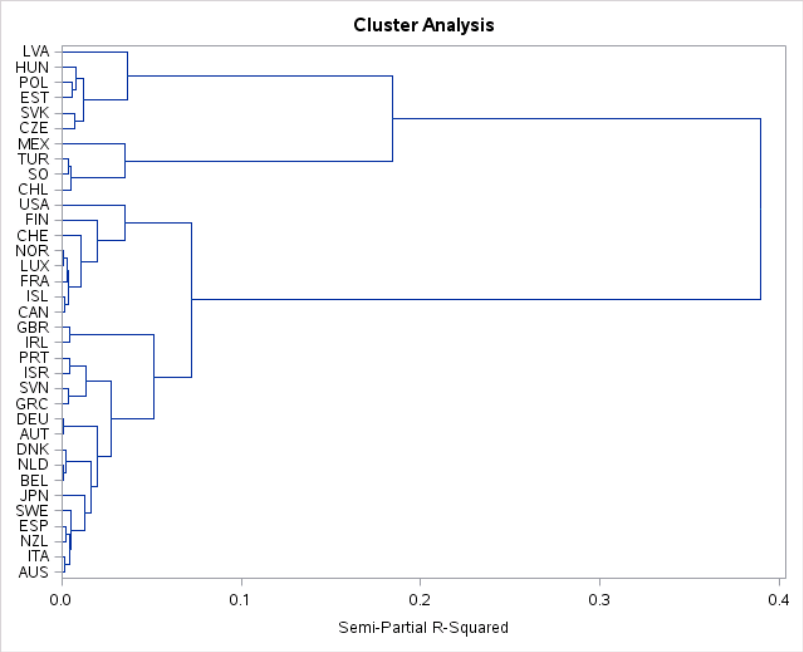

Figure 7. Tree of cluster analysis (dendrogram)—first period. Source: OECD.Stat database [23]—own calculations based on OECD database.

The main features of the clusters are presented by the cluster centroids in Table 6.

Cluster 1 (15 countries—Australia, Italy, New Zealand, Spain, Sweden, Japan, Belgium, the Netherlands, Denmark, Austria, Germany, Greece, Slovenia, Israel, Portugal).

Countries in these clusters are "middle", meaning they include some characteristics, like GDP or expenditures on health per capita, standardized death rates (SDR) of malignant neoplasms, of diseases of the NS, CS and RS. The real change in GDP per capita was the smallest between 2000 and 2008 (14.2%) while the expenditures on health per capita jumped more intensively in the same time span (by 30.7%). Health expenditure as the share of GDP was quite high in these countries and high was also the contribution of their governments on current health expenditures. The LE for women and men was as high as in the countries in Cluster 3, but one very significant difference can be visible between Clusters 1 and 3. The very high life expectancies at birth were achieved with much lower current expenditures on health per capita. The countries in this cluster can be positively rated due to low levels of SDR of mental and behavioral disorders, but negatively evaluated through very high SDR for diabetes mellitus.

Cluster 2 (two countries—Ireland, United Kingdom).

In this cluster only two countries were placed, both are geographically very closely located, and both are island lying. These countries have a higher GDP per capita compared to Cluster 1 with a higher increase in this indicator (16.3%). At the beginning of the analyzed period Ireland and GBR were in the "middle" of clusters based on health expenditures per capita, which were combined with a bit very high increase of these expenditures by nearly 64%. These strong increase of current expenditure on health per capita compared with the moderate change in GDP per capita caused the

highest gap between both real change indicators which stood at 47.3 p.p. Governments' expenditure on health as % of total health expenditures was the highest with a level of 78.4%. Positively can be rated the countries in this cluster due to a very low SDR for diabetes mellitus, but the standardized death rates for other illnesses were quite high. Cluster 2 had the second worst position based on SDR for malignant neoplasms, diseases of the nervous system and of the circulatory system. But the worst is their position from the point of view of SDR related to the diseases of the respiratory system. Household out-of-pocket payments on health (11.8%) was the lowest one among all of the clusters.

Cluster 3 (eight countries—Canada, Iceland, France, Luxembourg, Norway, Switzerland, Finland, United States).

These countries had the highest average level of GDP per capita and health expenditures per capita. The health expenditures (HE) per capita increased more rapidly compared to the changes of GDP/capita. Due to the very high current expenditure on health per capita the indicator of HE as % of GDP (8.6%) was the highest among all of the clusters. Government expenditure on health as % of the total HE was only 70.5% especially due to a very low rate in the USA (44.2%). Specific for the countries in Cluster 3 was the highest LE for females and males. Positively can be rated the cluster for lower levels of SDR for malignant neoplasms, diseases of the CS or RS. On the other hand, the very high LE in these eight countries can be the main reason for the highest SDR for mental and behavioral disorders and highest levels of SDR for diseases of the nervous system.

Custer 4 (four countries—Chile, South Korea, Turkey, Mexico).

The emerging and the least developed countries of the OECD were joined together into Cluster 4. Typical for these countries are very low levels of GDP per capita combined with the lowest current health expenses on health. The growth rate of health expenditures per capita reached an extremely high level of 61.2% and so the gap between the real changes of indicators x_2 and x_4 was as high as 33.6%. These countries had the lowest health expenditures share of GDP (4.9%), the lowest government expenditure on health as % of health expenses (53%) and surprisingly the highest household out-of-pocket payments on health (41.9%). The high household out-of-pocket payments in less developed countries is a risky condition for the overall health of the population, a danger of public health issues because the health expenses can be financed only by richer persons while the poorer population can be at risk of health and health care. According to the SDR data for malignant neoplasms and diseases of the circulatory system these countries achieved the lowest average levels among all five clusters. Very negatively should be rated the highest SDR for diabetes mellitus that averaged at 62 deaths per 100,000 population, with an extreme for Mexico at 121 deaths per 100,000. Not only the SDR for diabetes were high but also for diseases of the RS was the second highest between the analyzed clusters.

Cluster 5 (six countries—Czech Republic, Slovakia, Estonia, Poland, Hungary, Latvia).

The former communist countries created the last Cluster 5. These countries are similar not only due to their former communist regimes, due to their common entry into the European Union in 2004, due to their territory closeness, but also due to the chosen indicators. On average for the countries is typical the lowest GDP per capita level and second lower HE per capita. On the other side they reached the highest real GDP growth that averaged at 54.6% and the highest real change in the expenditures on health (75.8%). The health expenditures as % of GDP stood at 5.6%, but due to a strong increase of HE per capita the percentage can grow in the future. As a surprise of these East European countries is a quite high share of household out-of-pocket payments on health expenditure, that was with 24.6% the second largest. This cluster achieved the lowest levels of LE for women (77.1) and men (68.0). The low LE can be a result of an extremely high SDR for diseases of the CS (more than 770 deaths per 100,000) and the highest SDR for malignant neoplasms. Good results can be seen in the lowest SDR for mental and behavioral disorders, diseases of the nervous system and RS. These countries should focus on better national screening programs for early detection of initial cancer stages that could be treated with more successful results.

Table 6. Cluster centroids of OECD countries—first period.

Clusters of OCED countries	*cluster 1*	*cluster 2*	*cluster 3*	*cluster 4*	*cluster 5*
Number of countries	**15**	**2**	**8**	**4**	**6**
GDP per capita (PPP, curr. p.) in 2000	25 359	28 098	34 454	11 752	11 227
Real growth rate, GDP per capita, (2000 - 2008)	1.142	1.163	1.146	1.275	1.546
HExpend. per capita (PPP, curr. P.) in 2000	1 976	1 673	2 944	558	636
Real growth rate, HExpend. per capita, (2000 - 2008)	1.307	1.636	1.273	1.612	1.758
HExpend. (% of GDP) in 2000	7.8	6.0	8.6	4.9	5.6
HExpend. (government compulsory of total, %) in 2000	73.6	78.4	70.5	53.0	74.2
HExpend., Out of pocket pamynets (% of total) in 2000	19.9	11.8	18.4	41.9	24.6
LE_females (2000)	81.4	79.8	81.5	77.2	77.1
LE_males (2000)	75.6	74.8	75.7	71.4	68.0
SDR _MN (2000)	231.8	257.7	226.0	169.9	278.4
SDR_DM (2000)	23.6	13.1	17.7	62.1	15.9
SDR_MBD (2000)	17.8	21.4	31.5	23.0	4.3
SDR_NS (2000)	19.2	22.7	32.8	16.1	13.8
SDR_CS (2000)	384.7	435.1	353.1	259.6	772.6
SDR_RS (2000)	82.9	167.0	78.2	100.1	58.0

Source: OECD.Stat database [23]—own calculations based on OECD database.

3.3.2. Cluster Analysis—Second Period

For the second period of cluster analysis the variables used to create the homogenous clusters have been taken from the most recent period according to the availability of the concrete indicator. Variables x_1, x_3, x_5, x_6 represents the data from the end of the analyzed period, from the year 2016. Unfortunately, not all of the characteristics were available for most actual period, so for example the life expectancy for females (x_8) and also males (x_9) cover the year 2015, variables of mortality x_{10}–x_{15} are calculated for 2013 and the real indices of GDP per capita and health expenditures per capita (indicators x_2 and x_4) represent the real change in both indicators between 2009 and 2016. For cluster analysis six first most important principal components were used which explained more than 85% (see Figure 8) of the variation of the original dataset. The PCA was used due to a strong association between some pairs of the selected variables, the correlation coefficients can be found in Table 7.

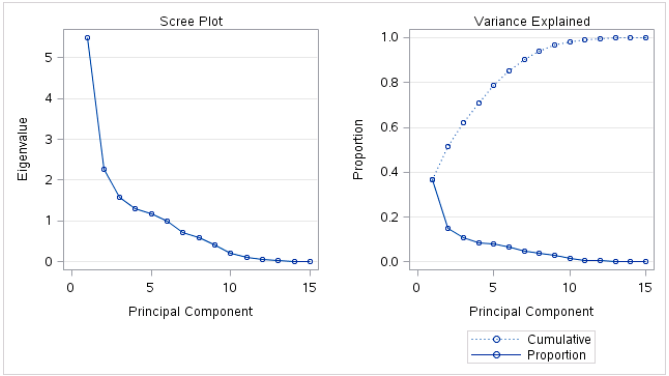

Figure 8. Scree plot of principal component analysis—second period. Source: OECD.Stat database [23]—own calculations based on OECD database.

In the second period of CA the 35 OECD countries were split into six relatively isolated clusters (see the cluster tree—Figure 9). The created clusters separated 17 most developed countries into one

large cluster. One cluster consists of Switzerland and the United Stated, the countries with a very high percentage of HE to GDP. Cluster three is created by countries with a very low real change in GDP. Clusters 4 and 6 consists of the less developed countries of the OECD. In the second period of CA also one cluster with only one object was created, Mexico was the only country that is not similar to any OECD countries according to used indicators for the analysis.

Table 7. Pearson's correlation coefficients (second period).

Variables	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{11}	x_{12}	x_{13}	x_{14}	x_{15}
x_1	1														
x_2	-0.072	1													
x_3	**0.829**	-0.259	1												
x_4	-0.125	0.457	-0.019	1											
x_5	0.353	-0.451	**0.797**	0.066	1										
x_6	0.327	-0.040	0.173	-0.095	0.012	1									
x_7	-0.528	0.050	-0.555	0.131	-0.435	**-0.723**	1								
x_8	0.432	-0.417	0.414	-0.042	0.380	0.315	-0.370	1							
x_9	0.558	-0.428	0.565	-0.103	0.480	0.361	-0.478	**0.864**	1						
x_{10}	-0.087	0.113	-0.145	-0.077	-0.101	0.247	-0.176	-0.238	-0.322	1					
x_{11}	-0.339	0.163	-0.341	0.004	-0.313	-0.429	0.448	-0.541	-0.378	-0.519	1				
x_{12}	0.586	-0.191	**0.728**	0.084	**0.622**	0.206	-0.418	0.187	0.455	0.079	-0.292	1			
x_{13}	0.310	-0.067	0.339	-0.044	0.270	0.162	-0.292	0.249	0.379	-0.258	-0.228	0.391	1		
x_{14}	-0.405	0.389	-0.486	0.011	-0.485	-0.063	0.296	**-0.698**	**-0.855**	0.575	0.012	-0.406	-0.312	1	
x_{15}	-0.083	0.199	-0.040	0.006	0.019	-0.059	-0.028	-0.188	0.032	-0.108	0.272	0.084	-0.149	-0.289	1

Source: OECD.Stat database [23]—own calculations based on OECD database.

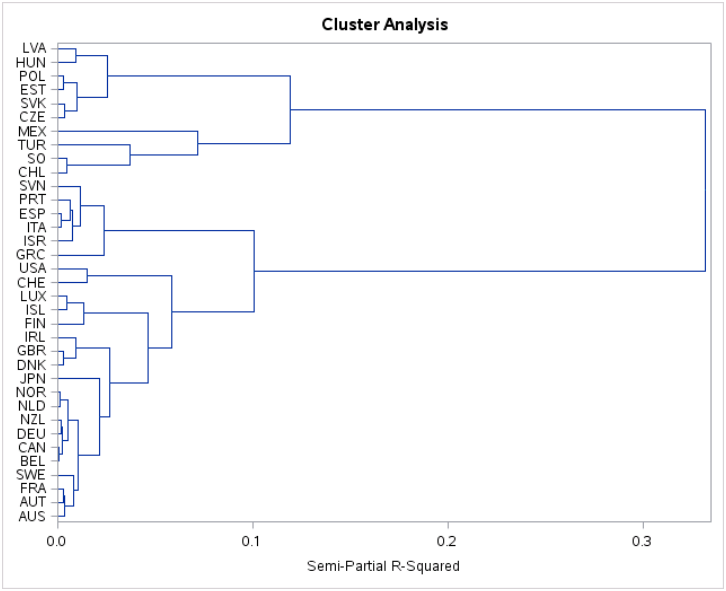

Figure 9. Tree of Cluster analysis (dendrogram)—second period. Source: OECD.Stat database [23]—own calculations based on OECD database.

The main features of the clusters are presented by the cluster centroids in Table 8.

Cluster 1 (17 countries—Australia, Austria, France, Sweden, Belgium, Canada, Germany, New Zealand, the Netherland, Norway, Japan, Denmark, United Kingdom, Ireland Finland, Iceland Luxembourg).

The first cluster joined together countries with a very high living standard. The average GDP per capita and HE per capita are the second highest between the clusters with a real growth between 2009 and 2016 by about 10% in the case of GDP per capita and by 12% for HE per capita. In these countries the government expenditures on health reached a maximal level of 78.9% while the household out-of-pocked was minimal (14.6%). The high living standard has been manifested in a very high LE for women (84.0) and men (79.7). Very positively should be rated the lowest SDR for diabetes mellitus,

and diseases of the CS. The high LE can be the reason for higher SDR for diseases of the nervous system and SDR for MBD.

Cluster 2 (two countries—Switzerland, United States).

Cluster 2 contains only two countries. For both countries are typically extremely high levels of GDP per capita ($60,112) and expenditure on health per capita ($8906). The GDP per capita increased in the time span from 2009 till 2016 in real terms only moderately by 6.9%, but the HE per capita increased by 20% which was the second highest growth among the clusters. The difference between both real changes ended with the highest value of 13.1 p.p. Health expenditure as % of GDP stood at 14.8%, this was the maximal ratio of all clusters. The LE at birth for females and males was in the "middle" of the clusters, not the best, but not the worst. According to the health expenditures per capita it was expected that these countries will achieve better results in the case of LE at birth for both sexes and also in the case of the standardized death rates. Between all clusters, Cluster 2 had the highest levels of SDR for MBD and SDR for the NS, third worst SDR for malignant neoplasms. On the other side positively can be rated the low death rates for diseases for RS, CS and diabetes mellitus.

Cluster 3 (six countries—Greece, Israel, Italy, Spain, Portugal, Slovenia).

In this cluster interestingly were joined together the most problematic countries of the EU, the so-called PIGS countries: Portugal, Italy, Greece, Spain with Slovenia and Israel. The GDP per capita and HE per capita of this cluster are in the "middle" of the clusters, but both characteristics between 2008 and 2016 did not change very positively. The real GDP per capita on average for this cluster stayed unchanged and the HE per capita in real terms declined by about 3%. The average decline for this cluster was very negatively influenced by strong declines especially in Greece. The LE at birth for females was the highest one (84.5) while for men the second highest (79.2). The high LE was reached also due to relatively lower SDR for diseases for the RS, NS, or CS. A bit worse were the SDR for malignant neoplasm.

Cluster 4 (three countries—Chile, South Korea, Turkey).

The emerging countries of the OECD merged together into Cluster 4. Only Mexico as another emerging country created a separate, solo cluster. These countries had a lower GDP per capita and, HE per capita than the former communist countries joined together in Cluster 6. Positively should be rated the highest average real increase of GDP per capita by almost 30% and real growth of HE per capita by 37.3%. The LE at birth was higher in this cluster compared with Clusters 5 and 6. Low were the SDR for malignant neoplasms and SDR for MBD. On the other hand, higher were the death rates for DM, in the case of other selected SDR the result of Cluster 4 can be rated as "middle".

Custer 5 (one country—Mexico).

In both periods of cluster analysis only one single—solo cluster was created. It means that according to the analyzed indicators Mexico is not similar to any other OECD country at all. Mexico can be considered as an "extreme country". The main reason for the separation are some extremely low or extremely high levels of selected indicators. For example, the GDP per capita ($18,583) and the HE per capita ($1080) were at extremely low levels. The real changes of both characteristics are moderate, so the assumption is not very positive for a greater growth in the nearest future. The health expenditures as a percent of GDP were minimal and as low as 5.8%. The lowest was the government expenditure on health (53%) but the household out-of-pocket payments on health were extremely high (41.9%). So, high household out-of-pocket payments are dangerous in an emerging country like Mexico. The health can be a luxury product-service for a lot of ordinary people. In Mexico, the SDR for DM, and diseases of the RS and CS, were the highest among the clusters. The lowest SDR were achieved in the case of SDR for MN, MBD, or diseases of the NS.

Cluster 6 (six countries—Czech Republic, Slovakia, Estonia, Poland, Hungary, Latvia).

The former communist countries joined again together into one separate cluster. These six countries created together a cluster also in the first period of the analysis, fortunately with much better results in the second period. For example, their average GDP per capita in the first period ($11,227) was the lowest one, it jumped to $29,202 in the second period, with a much better position between the clusters.

The HE per capita reached $2003. In these group of countries, the increase of the GDP per capita was higher than the increase of HE per capita. The LE at birth was the second lowest for females and also for males. The lower LE at birth is associated with the extremely high SDR for diseases of the circulatory system and malignant neoplasms. Positively should be rated the lowest SDR for diseases of the RS.

Table 8. Cluster centroids of OECD countries—second period.

Clusters of OCED countries	*cluster 1*	*cluster 2*	*cluster 3*	*cluster 4*	*cluster 5*	*cluster 6*
Number of countries	**17**	**2**	**6**	**3**	**1**	**6**
GDP per capita (PPP, curr. p.) in 2016	52 025	60 112	33 757	28 011	18 583	29 202
Real growth rate, GDP per capita, (2009 - 2016)	1.099	1.069	0.998	1.294	1.143	1.210
HExpend. per capita (PPP, curr. P.) in 2016	5 060	8 906	2 862	1 931	1 080	2 003
Real growth rate, Hexpend. per capita, (2009 - 2016)	1.120	1.200	0.969	1.373	1.080	1.171
HExpend. (% of GDP) in 2016	9.8	14.8	8.5	6.8	5.8	6.8
HExpend. (government compulsory of total, %) in 2016	78.9	56.4	67.4	65.5	51.7	72.1
HExpend., Out of pocket pamynets (% of total) in 2015	14.6	19.7	24.5	28.7	41.4	24.8
LE_females (2015)	84.0	83.2	84.5	82.5	77.7	80.7
LE_males (2015)	79.7	78.6	79.2	76.9	72.3	72.9
SDR _MN (2013)	202.9	182.7	203.2	180.4	113.1	247.3
SDR_DM (2013)	15.3	18.9	22.5	34.1	143.0	20.1
SDR_MBD (2013)	35.1	49.1	15.3	12.3	6.6	14.0
SDR_NS (2013)	38.8	41.1	23.7	34.0	14.3	17.8
SDR_CS (2013)	230.1	234.2	244.4	264.7	269.7	545.0
SDR_RS (2013)	66.1	63.0	64.8	85.5	93.0	53.0

Source: OECD.Stat database [23]—own calculations based on OECD database.

4. Discussion

The GDP per capita in PPP current prices jumped from an average level of USD 23,616.5 to USD 42,429.2. This variable belongs to the indicators of SD Goal 10 and the increase of the GDP per capita in OECD can be rated positively. In 2016 Mexico had the lowest while Luxembourg the highest living standard between the OECD Member States. The convergence of OECD countries from the GDP per capita point of view developed positively, the coefficient of variation decreased from a level of 43% in 2000 to 38.8% in 2016. It is a good signal of a convergence process of the GDP per capita of the OECD population. The average amount spent on health per capita increased from $1788 in 2000 to $3997 in 2016. The relative variability of HE per capita is higher compared to the CV of GDP/capita. In 2000 the CV of current expenditures on health per capita was as high as 55% and declined to 50.7% in 2016. High expenditure on health per capita was typical for countries which faced also a very high level of GDP per capita. The highest HE per capita in 2016 was reached in the United States ($9892). The assumption that between GDP and HE per capita exists a positive association was fulfilled. In 2016 the Pearson's correlation coefficient between both variables was very high and positive (r_{xy} = 0.83) and it means that in countries with high GDP per capita we can expect a high level of HE per capita and vice versa.

One of the assumptions was not fulfilled. The assumption was that the GDP per capita, as a very rough estimate of the of overall country's productivity, will grow more strongly than the HE per capita. The expectation that the productivity generates the growth of HE has not been confirmed. The real change GDP per capita belongs to the indicators of SD Goal 8. Almost in all OECD countries the increase of real GDP per capita was lower than the real change in HE per capita between 2000 and 2016. Most notable was the difference between both characteristics in Korea where the real GDP per capita increased in the selected time span by 69.7%, but the real HE per capita grow by 222.9%. In only two countries the real GDP per capita growth trespassed the real health expenses per capita

changes (Iceland, Turkey). Even in countries most affected by the economic crisis the HE per capita grows moderately. For example, in Greece where the real GDP per capita between 2000 and 2016 declined by 2.7% the HE increased by 9.7% and in Italy the GDP per capita dropped by 5.3%, but the real HE per capita changed oppositely and grow by 11.6%.

The strong growth of HE should positively affect the health outcome of the population in OECD countries. That is why selected indicators of public health were chosen for analysis, these indicators belong to the SD Goal 3. According to the expectation the LE at birth or at age 65 should increase and on the other hand the standardized death rates of some diseases should decline. LE at birth increased progressively in the OECD countries. The average LE for females was 73 years in 1970 and jumped to 83.2 in 2015 while for males the average value increased from 66.7 years to 77.9 years respectively. The LE for males was lower by 6.3 years compared to women's life expectancies in 1970 but the gap is closing. A very positive development was discovered for the LE at age 65. While the average LE at birth for women increased by about 14% and for man by 16.8%, the LE at age 65 increased more rapidly. For women the growth reached 35% and for men the increase achieved 40%.

The increasing life expectancy, especially the LE at higher ages belongs to the main reasons for increases of the HE per capita. The aging of the population is nowadays an issue that is often discussed from the perspective of the economic aspects of aging

For the multivariate analysis the PCA and cluster analysis were used. In the case of a strong linear association between the indicators the most important principal components were used instead of the original strongly correlated dataset. The OECD countries were grouped into clusters based on their similarity. For classification 15 indicators were used: Some indicators of the economic situation in the countries, indicators of health expenditures, life expectancy at birth and standardized death rates of noncommunicable diseases. The selected variables are part of the SD goals 3, 8 and 10.

In the first period of CA the 35 OECD countries were split into five clusters. The created clusters separated the most developed countries into two clusters, one cluster with 15 objects and one with eight objects. On the other hand, the less developed OECD countries were classified into a cluster with four objects, the former communist countries were separated into a cluster with six objects. One cluster content only two countries (Ireland and the United Kingdom). The 15 very developed OECD countries in Cluster 1 can be rated as "middle" regarding some characteristics, like GDP or expenditures on health per capita. The LE for women and men was as high as in the countries in Cluster 3, but one very significant difference can be visible between Clusters 1 and 3. The very high life expectancies at birth in Cluster 1 were achieved with much lower current expenditures on health per capita. In the second cluster, only two countries were placed, both are geographically very closely located, and both are island lying (Ireland, United Kingdom). Their governments' expenditure on health as % of total health expenditures was the highest while household out-of-pocket payments on health (11.8%) was the lowest one among all clusters. Cluster 2 had the worst position for SDR related to the diseases of the respiratory system. In the third cluster, the LE for females and males was the highest and this can be the reason for the highest SDR for mental and behavioral disorders and highest levels of SDR for diseases of the NS. In Cluster 4, the emerging and the least developed countries of the OECD were joined together. Typical for these countries are very low levels of GDP per capita combined with the lowest HE per capita. These countries had the lowest government expenditure on health as % of health expenses (53%) and surprisingly the highest household out-of-pocket payments on health (41.9%). The high household out-of-pocket payments in less developed countries is a risky condition for the overall health of the population. The health expenses can be financed only by richer persons while the poorer population can be at risk of health and health care. Very negatively should be rated the highest SDR for diabetes mellitus (especially in Mexico). In the last cluster the former communist countries joined together. These countries are similar not only due to their former communist regimes, due to their territory closeness, but also due to the chosen indicators. These countries had in the first period the lowest GDP per capita level and second lower HE per capita. The low levels were combined with the highest real GDP growth that averaged at 54.6% and the highest real change in the HE per capita

(75.8%). Former communist countries had the lowest levels of LE for women (77.1) and men (68.0). The low LE can be a result of an extremely high SDR for diseases of the CS (more than 770 deaths per 100,000) and the highest SDR for malignant neoplasms. These countries should focus on better national screening programs for early detection of initial cancer stages that could be treated with a more successful result.

In the second period of CA the OECD countries were split into six relatively isolated clusters. Seventeen most developed countries created one large cluster—Cluster 1. These countries with a very high living standard had the highest government expenditures on health (78.9. The high living standard has been manifested in a very high LE for women (84.0) and men (79.7) and the lowest SDR for diabetes mellitus, and diseases of the CS. The second cluster consists of Switzerland and the United Stated. For both countries are typically extremely high GDP per capita ($60,112) and HE per capita ($8906). The GDP per capita increased in the time span from 2009 till 2016 in real terms only moderately by 6.9%, but the HE per capita increased by 20%. HE as % of GDP stood at 14.8%, this was the maximal ratio of all clusters. According to the extremely high HE per capita it was expected that these countries will achieve better results in the case of LE and SDR for noncommunicable diseases. The PIGS countries (Portugal, Italy, Greece, Spain) together with Slovenia and Israel joined together into Cluster 3. The GDP per capita and HE per capita of this cluster are in the "middle" of the clusters, but the growth rates of both characteristics between 2008 and 2016 were not very positive. The real GDP per capita on average for this cluster stayed unchanged and the HE per capita in real terms declined by about 3% mainly as a result of a strong decline in Greece. The LE at birth for females was the highest one (84.5) while for men the second highest (79.2). Clusters 4 and 6 consists of the less developed countries of the OECD. The emerging countries of the OECD merged together into Cluster 4 (except Mexico that created solo cluster). These countries had a lower GDP per capita and, HE per capita than the former communist countries joined together in Cluster 6. Positively should be rated the highest average real increase of GDP per capita by almost 30% and real growth of HE per capita by 37.3%. Cluster 5 is a solo cluster that includes only one object—Mexico. Mexico is, according to the used data set, not similar to any other OECD country, therefore Mexico can be considered as an "extreme country". The main reason for the separation are extremely low or extremely high levels of selected variables. The GDP per capita ($18,583) and the HE per capita ($1080) were extremely low. The HE as a percent of GDP were minimal and as low as 5.8%, lowest were also the government expenditures on health (53%), but the household out-of-pocket payments on health were extremely high (41.9%). This very high household out-of-pocket payments are dangerous in an emerging country, like Mexico. Health care can be a luxury product-service for a lot of ordinary people. This may be this is the reason for the highest SDR for DM, and diseases of the RS. The former communist countries joined again together into one cluster, Cluster 6. The same six countries created a cluster that was also in the first period of the CA. In the second period they reached much better results compared with the first period. Their average GDP per capita in the first period ($11,227) was the lowest one and it jumped to $29,202 in the second period. In these countries the increase of the GDP per capita was higher than the increase of HE per capita. The LE at birth was the second lowest for females and males. The lower LE at birth is associated with the extremely high SDR for diseases of the CS and MN.

The analyses of status and development of indicators that are part of the SDGs are very important for achieving better results for sustainable growth. These analyses could help governments find weaknesses, react, and find the best solutions to reach the goals of Agenda 2030.

Author Contributions: S.M. and V.L. contributed equally to the development of the present paper, all the phases have been discussed and worked by S.M. and V.L.

Funding: The research was financed by the VEGA 1/0376/17 project.

Acknowledgments: This paper was supported by the Slovak Scientific Grant Agency as part of the research project VEGA 1/0376/17.

Conflicts of Interest: The authors declare no conflict of interest.

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