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COMPARATIVE ANALYSIS OF THE KEY FACTORS INFLUENCING HEALTHCARE SYSTEMS OF OECD COUNTRIES

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Abstract

The Health sector, as a part of the national economy, is extremely important for economic development. A well organized and operating healthcare system constitutes an important notion for both patients and national policy. That is why the organisation of healthcare systems is the subject of reform in many countries. The aim of this study is to identify homogeneous groups of countries from the OECD in terms of the level of delivery of medical services. Countries considered in the study will be analysed through the prism of selected characteristics. The results of the study will form the basis for international comparisons and application of solutions used by countries with better healthcare systems. The study will be backed up by a chosen multivariate statistical analysis — cluster analysis.

JEL classification: I10, I11, C38
Keywords: health sector, healthcare system, cluster analysis

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Introduction

The health sector is extremely important for economic development of a country. The definition of healthcare plays a basic role in public healthcare policy. Hence an efficient, well organized healthcare sector is crucial not only from the perspective of patient satisfaction but also from the perspective of managers (Alemi & Gustafson, 2006, pp. 1-50; Carroll, 2009, pp. 1-15; Martin et al., 2012, pp. 316-321). All countries are trying to improve the functioning of healthcare and that is why managers and appropriate authorities are trying to apply the best practices of other countries.

Undoubtedly, the OECD constitutes an extremely diversified group of countries. These countries differ in many ways such as language, culture and organization. Each country's economy is organized in a slightly different way. Therefore, it should not be surprising that comparative analyses of countries from this group should be conducted with due diligence. However, identification of possible directions of changes can be done only with the use of comparative analysis. The problem of healthcare performance has been the subject of research all over the world (Journard et al., 2010; Lupi et al., 2011, pp. 2-5; Papadopouls, 2005, pp. 289-295; Krzeczewski, 2015, pp. 59-66, Pastusiak & Krzeczwski, 2012, pp. 53-67).

The aim of this study is to identify homogeneous groups of countries from the OECD in terms of the level of allocation of medical services. The article is based on the following hypothesis: there are no significant changes in the distinguished groups of countries between the years 2009-2014. Selected countries will be analysed through the prism of characteristics connected with healthcare: expenditure, resources, activities and health status. The study will be backed up by a multivariate statistical analysis - cluster analysis, which finds similarities of objects (in this study – countries) described as data and puts them into groups. This method has been widely used in the healthcare sector by many different research centres (Chan et al., 2006, pp. 139-140; Roy et al., 2009, pp. 51-60; Wendt, 2009, pp. 430-434; Liu & Liu, 2011, pp. 1400-1404). The analysis will lead to the possibility of creating a classification of the OECD countries based on healthcare problems which may constitute valuable information for all managers of healthcare units, not to mention the national authorities.

Previous research

Research connected with the performance of healthcare and clustering has rapidly grown over the last few years. Many studies were conducted on the performance of healthcare both from macro- and micro-perspectives. The performance of the healthcare sector is undoubtedly a complex phenomenon and that is why it can be analysed from many different perspectives. As a result, in the literature there can be found studies conducted by e.g. comparative analysis methods, which consider the healthcare sector with the use of different variables.

Wendt (2012) conducted research on the healthcare systems of 15 European countries. The purpose of this research was to use cluster analysis to identify certain types of healthcare systems and to group countries into clusters. According to this analysis countries were classified into 3 groups: health service provision-oriented type, universal coverage – controlled access type, low budget – restricted access type.

Penno et al. (2013) did research that evaluated how policy makers in different jurisdictions construct the health funding formulae. The authors carried out a comparative analysis of key components of the funding formulae across seven high-income and predominantly publically financed health systems: in New Zealand, England, Scotland, the Netherlands, the state of New South Wales in Australia, the Canadian province of Ontario, and the city of Stockholm, Sweden. Due to the results of the research, the authors concluded that despite broadly similar frameworks, there are distinct differences in the composition of the formulae across the seven healthcare systems.

Another interesting and important study was conducted by Hadad et al. (2013) who compared the efficiency of healthcare systems using two models: one incorporating mostly inputs that are considered to be within the discretionary control of the healthcare system (i.e., physicians' density, inpatient bed density, and health expenditure), and another, including mostly inputs beyond healthcare systems' control (i.e. GDP, health expenditure). Secondly, they analysed whether institutional arrangements, population behavior, socioeconomic or environmental determinants are associated with healthcare systems' efficiency. The authors concluded that countries striving to improve their healthcare systems' efficiency should aim to influence

population behavior and welfare rather than only ensure adequate medical care. What is more, they may consider avoiding specific institutional arrangements (e.g. multiple insurers). Research connected with comparative analysis of healthcare systems on a micro-level has also been broadly conducted.

Multivariate statistical inference methods - cluster analysis

Numerical techniques for deriving classifications originated largely in natural sciences such as biology. Cluster analysis has different names, such as Q analysis, typology construction, classification analysis and numerical taxonomy, which were used in studies in e.g. biology, sociology, economics, psychology or business (Hair et al., 2010). Nowadays cluster analysis[1] is the most commonly used term of procedures which seek to uncover groups in data. Cluster analysis is a group of multivariate techniques whose primary purpose is to group objects based on the characteristics they possess (Setyaningsih, 2012, pp. 286-292). Algorithms of cluster analysis can be classified into two basic groups: hierarchical methods (Gatignon, 2010, pp. 295-320) and nonhierarchical methods (Everitt et al. 2011, pp. 1-110). Cluster analysis tends to be the most familiar of all approaches to exploratory multivariate analysis, although it is not always thought of as a multivariate technique parallel to, for example, principal components analysis. (Drennan, 2010, pp. 309-315)

The clustering solutions are found by applying an algorithm which determines the rules by which observations are aggregated. Algorithms can be classified into two basic groups. The first group consists of hierarchical methods which provide algorithms in which observations are added to each other one by one in a treelike fashion. As a result of these methods of aggregation the dendrogram is created. These methods do not require a prior application of the number of clusters. (Gatignon, 2010, pp. 295-320)

The second group deals with nonhierarchical clustering techniques. The group of nonhierarchical methods includes e.g. the single linkage method, complete

1 What is a cluster? Unfortunately, there is no universally accepted definition. A cluster is a group of items in which each item is "close" (in some appropriate sense) to a central item of a cluster and that members of different clusters are "far away" from each other (Izenman, 2008, pp. 407-450).

Table 1: Letter abbreviations

Country	Abbreviation	Country	Abbreviation
Australia	AU	Korea	LV
Austria	AT	Latvia	KR
Belgium	BE	Luxembourg	LU
Canada	CA	Mexico	MX
Chile	CL	Netherlands	NL
Czech Republic	CZ	New Zealand	NZ
Denmark	DK	Norway	NO
Estonia	EE	Poland	PL
Finland	FI	Portugal	PT
France	FR	Slovak Republic	SK
Germany	DE	Slovenia	SI
Greece	EL	Spain	SP
Hungary	HU	Sweden	SE
Iceland	IS	Switzerland	CH
Ireland	IE	Turkey	TR
Israel	IL	United Kingdom	UK
Italy	IT	United States	US
Japan	JP		

Source: Own study

linkage method, unweighted pair-group method using arithmetic averages (UPGMA) and Ward method (Everitt, 2011,p p. 1-110).

Data and results

Empirical data and the method

The conducted research was based on the data obtained from the Organisation for Economic Co-operation and Development Database. The empirical data used in the study applied to healthcare systems between years 2009-2014. The main objects of the study were countries. For analytical purposes letter abbreviations were assigned to the countries' names (see Table 1).

Cluster analysis method was chosen because it provided classification of the countries in question, according to the chosen criteria. Before the cluster analysis was conducted, the variables were standardized by the following formula:

$$d(x,y) = \sqrt{\sum_{i=1}^{p}(x_i - y_i)^2} \quad (1)$$

where: x = (x1,…,xp),
y = (y1,…,yp),

The research was carried out with an assumption of Euclidean distance as a method of distance calculation (see equation 2):

$$\bar{z}_{l,k} = \frac{x_{lk} - \bar{x}_{lk}}{S_k}, \quad (2)$$

where: l = object,
k = variable,
$\bar{x}_{lk}$ = arithmetic average
S_k = the standard deviation of the variable sample.

Finally, the Ward method was chosen as one of the agglomeration methods of creating clusters. This method is the fusion of two clusters and it is based on the size of an error sum-of-squares criterion. The objective at each stage is to minimize the increase in the total within-cluster error sum of squares, E, given by (Everitt et al., 2011, pp. 1-110):

$$E = \sum_{m=1}^{g} E_m, \quad (3)$$

where: $E_m = \sum_{l=1}^{n_m}\sum_{k=1}^{p_k}\left(x_{ml,k} - \bar{x}_{m.k}\right)^2$

$\bar{x}_{m.k} = \left(\frac{1}{n_m}\right)\sum_{l=1}^{n_m} \grave{x}_{ml,k}$, (the mean of the m^{th} cluster for the kth variable), being the score on the k^{th} variable (k= 1,…, p),

xml,k for the l^{th} object (l=1,…,nm) in the m^{th} cluster (m=1,…,g).

The countries were analysed according to four groups of data: health expenditure, healthcare resources, healthcare activities and health status. According to indicators used in healthcare activities, the author decided to concentrate on those connected with inpatient (hospital) care, due to insufficient availability and comparability of data. Into those groups six different variables were assigned. Table 2 presents the indicators chosen for comparative analysis.

Results

The conducted analysis considered the performance of OECD countries' healthcare systems in the years 2009-2014. At first, the tendencies in values of the selected variables were examined. Figures 1 – 6 present the tendencies.

As for current health expenditure, it should be said that almost all countries did not exceed the level of 5000 PPP$. The exceptions were: Norway, Sweden, Switzerland, Luxembourg, The Netherlands and United States. Countries that were characterized by the lowest level of current health expenditures were: Korea, Mexico and Turkey.

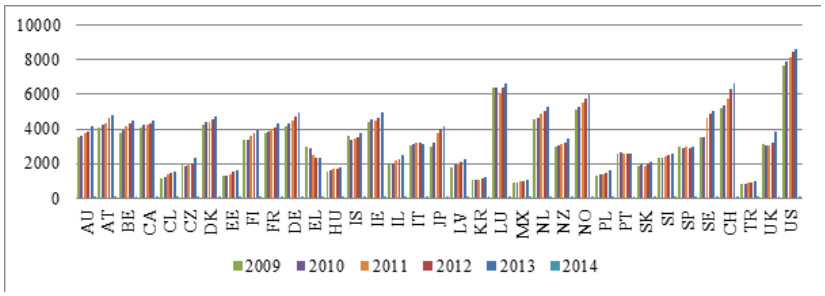
As far as out-of-pocket expenditures are concerned (see Figure 2) the biggest share belonged to Mexico, Korea, Latvia, Chile and since 2013 also Greece. In Chile the healthcare system is based on public and private insurance. Only the wealthiest citizens have access to public healthcare. On the other hand, as research indicates, the greatest health needs are reported by people socially insured. That is why the size of private expenditure of Chile's citizens are so big. A similar situation occurs in Mexico. Total health expenditure on health exceeds the level of 6% GDP, while the private 4% GDP (OECD, http://www.oecd.org/). The private healthcare system is rapidly developing – almost 3 mln of the wealthiest citizens and foreigners working in Mexico profit from private healthcare systems. Hence the out-of-pocket expenditures are so high in comparison with other countries. In Korea on the other hand, the share of health expenditure in GDP exceeds the level of 7,6% (3,5% GDP

Table 2: Indicators for comparative analysis of healthcare systems

Indicator	Description
Health expenditure: Current expenditure on health [in purchasing power parity in US $]	final consumption expenditure on healthcare goods and services, including those provided directly to individuals as well as collective services
Out-of-pocket expenditure, % of current expenditure on health	expenditure of households presented as a share of current expenditure on health
Healthcare resources: Total hospital beds [per 1000 inhabitants]	all hospital beds which are regularly maintained and staffed and immediately available for the care of admitted patients
Practicing physicians [per 1000 inhabitants]	physicians who provide services directly to patients, including e.g.: people who have completed studies in medicine at university level and who are licensed to practice; interns and resident physicians; foreign physicians licensed to practice and actively practicing in the country. From this group the following are excluded, e.g.: students who have not graduated yet; dentists and dental surgeons; physicians working in administration, research and in other posts that exclude direct contact with patients.
Healthcare activities: Average length of stay, all causes [in days]	calculated by dividing the number of bed-days by the number of discharges during the year (including: all hospitals, healthy newborns; excluding: day cases)
Health status: Life expectancy at birth	the average number of years that a person at that age can be expected to live, assuming that age-specific mortality levels remain constant

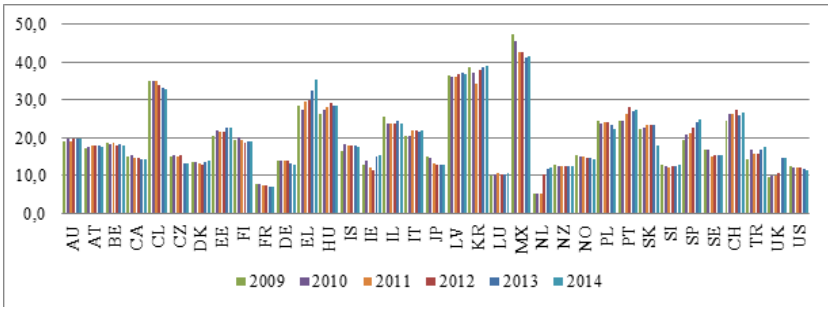
Source: OECD (2013). OCED. Health Data 2013 – Definitions, Sources and Methods. Health expenditure and financing. Retrieved from: http://www.oecd.org/health/health-systems/oecdhealthdata.htm, OECD (2013a). OCED. Health Data 2013 – Definitions, Sources and Methods. Health status. Retrieved from: http://www.oecd.org/health/health-systems/oecdhealthdata.htm, OECD (2013). OCED. Health Data 2013 – Definitions, Sources and Methods. Healthcare resources. Retrieved from: http://www.oecd.org/health/health-systems/oecdhealthdata.htm.

Figure 1: Current health expenditures in years 2009-2014 [PPP$, current prices]



Source: Own elaboration based on data retrieved from OECD Database: http://stats.oecd.org/

Figure 2: Out-of-pocket expenditure in the years 2009-2014 [% of current health expenditure]



Source: Own elaboration based on data retrieved from OECD Database: http://stats.oecd.org/

constitutes private expenditure).

As for the number of physicians (see Figure 3) in most cases this indicator did not exceed the level of 4 physicians per 1000 population. Only in Austria and Greece was this level exceeded significantly.

The lowest level of hospital beds (see Figure 4) was recorded in Chile and Mexico. Countries that are distinguished by the highest level of hospital beds were Japan and Latvia.

The highest level of the average length of stay (see Figure 5) occurs in Japan and Latvia. This indicator may constitute an early warning indicator of the quality of medical services. Though not all of the diseases are so complicated to keep the patient more than 15 days in a hospital bed. If the level of this indicator is so high, it may suggest the need for an internal audit of hospital processes.

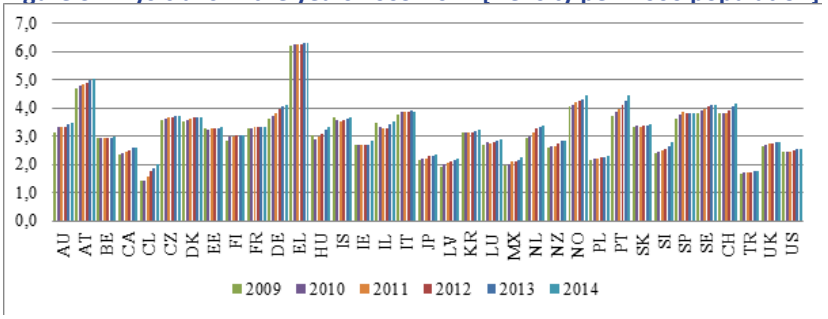
As for life expectancy (see Figure 6) in most cases it exceeds the level of 80 years. Only in Mexico, Turkey and Korea it is under the level of 75 years.

Moving forward to the results of cluster analysis, in all the analysed years, 7 groups were distinguished. Figure 7 presents the results of cluster analysis in the year 2014.

In order to investigate the stability of countries belonging to different groups, analysis was conducted over the years 2009-2014. The results of such analysis are presented in Table 4.

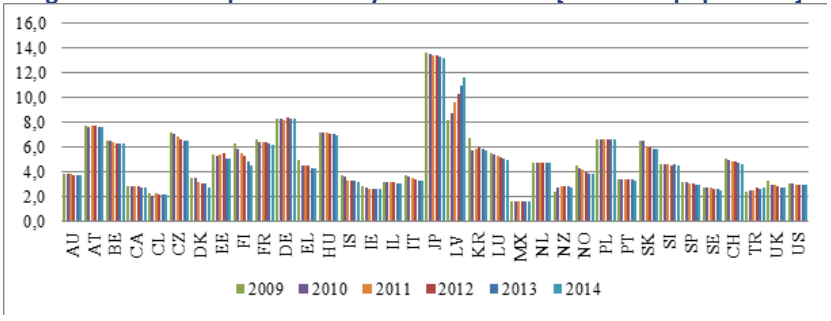
All the identified groups of countries tend to be quite homogenous, in terms of the analysed variables. The mean values of the examined indicators differed between

Figure 3: Physicians in the years 2009-2014 [Density per 1 000 population]



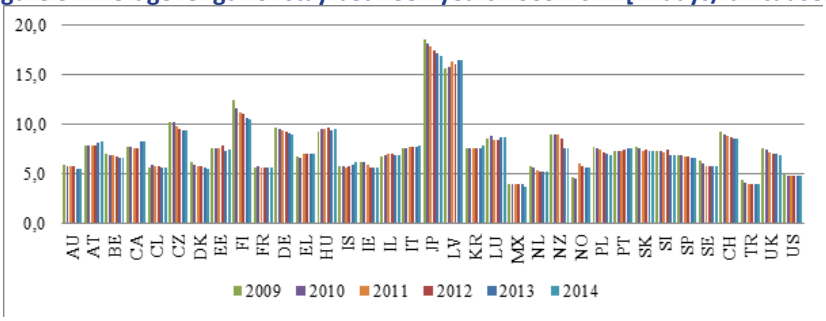
Source: Own elaboration based on data retrieved from OECD Database: http://stats.oecd.org/

Figure 4: Total hospital beds in years 2009-2014 [Per 1 000 population]



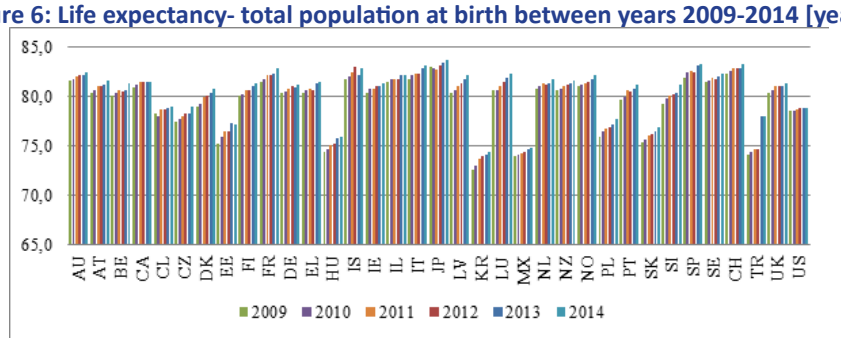
Source: Own elaboration based on data retrieved from OECD Database: http://stats.oecd.org/

Figure 5: Average length of stay between years 2009-2014 [in days/ all causes]



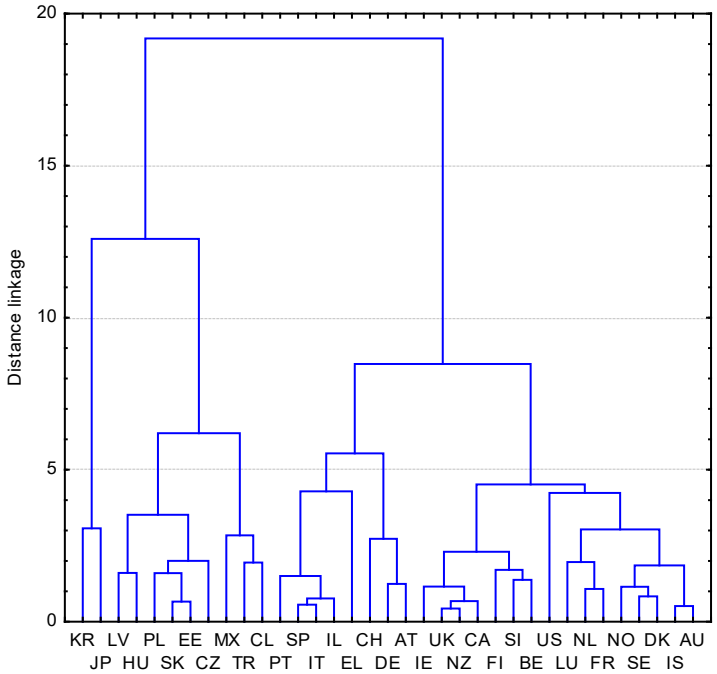
Source: Own elaboration based on data retrieved from OECD Database: http://stats.oecd.org/

Figure 6: Life expectancy- total population at birth between years 2009-2014 [years]



Source: Own elaboration based on data retrieved from OECD Database: http://stats.oecd.org/

Figure 7: Hierarchical cluster analysis – year 2014: dendrogram using Ward method, Euclidean distance



Source: Own calculations in Statistica PL.
Note: for countries abbreviations see Table 1.

Table 3: Average values of indicators for selected groups of countries

Indicator	Groups		
	1	2	3
Out-of-pocket expenditure, % of current expenditure on health	25	25	30
Total hospital beds [per 1000 inhabitants]	10	7	2
Average length of stay, all causes [in days]	13	10	5
Life expectancy at birth	78	77	76

Source: Own calculations

the groups. For example, the first group had an average of 10 beds per 1000 inhabitants, 13 days of stay and 78 years of life expectancy (see Table 3).

Countries that significantly changed their groups over the period were countries from groups 4, 5, 6. Finland and Greece, however were eventually assigned to appropriate groups. The movement of Finland was connected with the improvement of indicators. The case of Greece was connected with an unstable economic situation that affected the public sphere.

However, while comparing these results with the most popular division of healthcare systems (Bismarck model, Beveridge model, Siemaszko model and residual model of healthcare financing) the results differ significantly. There is a lack of homogeneity in groups created by the authors in terms of the four basic models mentioned. If the countries were divided by 4 different models of financing, they would not be homogenous in terms of variables analysed in the paper. As for the Czech Republic in the years 2010, 2011 and 2014 the level of the indicators was similar to those of group 2 which was formed from central-eastern countries.

In most cases some regional connections can be observed. For example, group 1 gathers Japan and Korea and group 2 countries of the former Eastern bloc. What is more, the countries of the former Eastern bloc formed a coherent group in the analysed period. As for group number 3 it was also coherent in the whole analysed period. Those countries represent a similar level of healthcare standards however it should be remarked that Turkey has the most regulated healthcare system in terms of legal and institutional aspects. Clusters 4-7 were characterized by a larger variability in time. That was connected with the direction of changes in the values of the considered variables. Greece constitutes the best example of this phenomenon. It should be underlined that Greece changed groups three times, which was connected for example with their unstable economic situation that also affected the public sphere.

Conclusions

To sum up, the research gave an overview of similarities between OECD countries in terms of their healthcare systems.

The classification based on type of systems and regional classification, typically used in this type of research, does not necessarily allow for the construction of homogeneous comparison groups.

Multi-dimensional cluster analysis was able to extract homogeneous comparative groups of countries. These groupings revealed countries providing medical services on a similar level, but not necessarily close regionally or in terms of the current funding system. Nevertheless, groups 1 and 2 showed a regional and systemic closeness, which according to the author, confirms the credibility of the grouping.

The analysis could be further improved by backing it up with details related to the methods of financing healthcare services, legal aspects, and many other factors connected with the quality of healthcare processes. That is why this analysis should be considered a starting point for further and more detailed research.

Table 4: Grouping countries between the years 2009-2014

GROUP	COUNTRY		2009	2010	2011	2012	2013	2014
1	Japan	JP	1	1	1	1	1	1
	Korea	KR	1	1	1	1	1	1
2	Latvia	LV	2	2	2	2	3	2
	Estonia	EE	2	2	2	2	2	2
	Hungary	HU	2	2	2	2	2	2
	Poland	PL	2	2	2	2	2	2
	Slovak Republic	SK	2	2	2	2	2	2
3	Chile	CL	3	3	3	3	3	3
	Mexico	MX	3	3	3	3	3	3
	Turkey	TR	3	3	3	3	3	3
4	Greece	EL	4	7	7	6	4	4
	Finland	FI	4	6	6	6	6	6
	Czech Republic	CZK	4	2	2	6	6	2
	Switzerland	CH	4	6	6	6	5	5
	Germany	DE	4	6	6	6	5	5
	Austria	AT	4	6	6	6	5	5
5	New Zealand	NZ	5	5	5	4	6	6
	Slovenia	SI	5	5	5	4	6	6
	United Kingdom	UK	5	5	5	4	6	6
	Ireland	IE	5	5	5	4	6	6
	Canada	CA	5	5	5	4	6	6
6	Belgium	BE	6	6	6	5	6	6
	United States	US	6	6	4	5	7	7
	Luxembourg	LU	6	6	4	5	6	7
	Norway	NO	6	6	4	5	7	7
	Denmark	DK	6	6	4	5	7	7
	Netherlands	NL	6	6	4	5	7	7
	France	FR	6	6	4	5	6	7
7	Australia	AU	7	7	7	7	7	7
	Iceland	IS	7	7	7	7	7	7
	Israel	IL	7	7	7	7	4	4
	Italy	IT	7	7	7	7	4	4
	Portugal	PT	7	7	7	7	4	4
	Spain	SP	7	7	7	7	4	4
	Sweden	SE	7	7	4	5	7	7

Source: Own calculations

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