Establishing the health status of Romanians in a European context

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Abstract

We intend to analyze the opinion of the population about the health status of the individuals from 20 European countries. The self assessed health (SAH) data are associated to an ordinal variable X. Our final aim is to establish the position of Romania in this European context from the health status point of view.

The statistical analysis is based on more complementary indices. The mean of X is generally not adequate as an indicator for this type of data. Our study used also two other indicators which are specific for ordinal variables. So, in the present research it was applied a polarization index POA and also an inequality Gini coefficient IGO adapted for SAH data. Comparisons of all these results are also made.

Keywords: *SAH data, health status, mean, polarization, inequality, indicators, Europe.*

1. Problem formulation

The present paper's aim is to establish Romania's position in a European context, taking as a unique evaluation criterion the health status of the inhabitants of the corresponding countries.

In the current research we have used representative samples containing responses from persons from 20 European countries. In fact, the data regarding the health status in European states was obtained from the paper of Cowell and Flachaire ([8], 2014). The initial source of the data used in [8] is in fact World Values Survey 1981- 2008, Official aggregate v.20090901, year 2009, which used data from the 5th wave, conducted in 2005-2008 over 56 countries which belong to the entire world.

We shall focus our statistical analysis on the population's answers to the question *Q1* regarding the individual health status. In fact, we have the following form of question *Q1*: "All in all, how would you describe your state of health these days? Would you say it is : poor (code 1), fair (code 2), good (code 3), very good (code 4)". So, the persons who were interviewed have four possibilities to answer with a codification that is inversed compared to that used in [8].

In the following paragraphs, we will attempt to construct a hierarchy for the 20 European countries for which we have answers to question *Q1* regarding the perception of the individual health status.

2. Data and indicators

We must underline the fact that the answers to question *Q1* are actually self-assessed health data (SAH data, for short). The random variables attached to SAH data are ordinal and there is a hierarchy between the answering classes. As a consequence, the selected statistical analysis models will have to work with ordinal variables. We mention for this step, the book of Agresti [1] in which are presented the different particularities of modelling systems which have ordinal variables as components.

We consider an ordinal variable X defined by 4 classes C_1 , C_2 , C_3 , C_4. All the elements within a class C_i are indistinguishable one from the other. Nevertheless, if $1 \le i < j \le 4$, then any element belong to class C_i is considered "inferior" to any of the elements from class C_j .

We will denote respectively by f_j , p_j , s_j the frequency, the probability and the score associated to the given importance of a group C_j , $1 \le j \le 4$. Evidently we have the following relations :

$$p_j = f_j \,/\, (f_1 + f_2 + f_3 + f_4) \qquad\qquad 0 \le s_1 < s_2 < s_3 < s_4$$

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Within a European country t , $1 \le t \le 20$, we have data concerning the frequencies $f_{k,t}$ for which the responds to question *Q1*, have chosen the answer code k, $k \in \{1, 2, 3, 4\}$. The information regarding the distribution of the types of answers by country is presented in *Table 2.1*.

Table 2.1. Frequences of the population response at the question *Q1*.

Nr.	Country	Abbv.	Health code			
			1	2	3	4
1	Bulgaria	BG	150	310	389	149
2	Switzerland	CH	33	173	635	400
3	Cyprus	CY	65	184	387	413
4	Spain	ES	48	195	716	237
5	Finland	FI	61	284	437	232
6	France	FR	58	225	418	300
7	United_Kingdom	GB	87	196	412	345
8	Georgia	GE	296	574	439	189
9	Germany	DE	148	538	908	458
10	Italy	IT	34	228	562	188
11	Moldova	MD	117	354	443	107
12	Netherlands	NL	42	262	497	247
13	Norway	NO	46	165	388	426
14	Poland	PL	127	331	365	175
15	Romania	RO	254	569	776	175
16	Russia	RU	256	911	721	134
17	Serbia	RS	147	406	431	226
18	Slovenia	SI	144	302	369	220
19	Sweden	SE	33	187	430	353
20	Ukraine	UA	132	378	412	76

In order to establish Romania's position in a European context using as unique criterion the health status perceived by the population, we will choose several indicators which are attached to the evaluation processes of the mean, polarization and inequality. Concretely, for an ordinal variable X with four classes, we will use the indexes: $Mean(X\,;\,\underline{s})$, $POA(X)$, $IGO(X)$. In the following we will be presenting more details.

Therefore, $Mean(X\,;\,\underline{s})$ represents the mean of variable X weighted with the scores $\underline{s} = (s_1, s_2, s_3, s_4)$, that is:

$$Mean(X\,;\,\underline{s}) = s_1 \,.\, p_1 + s_2 \,.\, p_2 + s_3 \,.\, p_3 + s_4 \,.\, p_4$$

Practically, the value $Mean(X\,;\,\underline{s})$ cannot be effectively evaluated since we do not know the values of the scores $\underline{s}$ attached to the ordinal classes. The weights $\underline{s}$ are subjective and modifying these scores affects the value of the coefficient $Mean(X\,;\,\underline{s})$.

So, for the ordinal variables X we cannot talk of a classical variance coefficient, since we cannot compute the mean of X.

In the papers of Berry & Mielke [3] and Blair & Lacy [4] there are proposed different variation indicators for ordinal variables. Blair & Lacy suggests in [4] several classes of variation indicators based on the cumulative distribution function of the ordinal variable. In the following, we will denote *POA* one of the variation indicators mentionned in [4] and which has been subsequently studied in the doctoral thesis of Apouey [2]. The interesting properties of the index *POA* are described at length by Apouey in his paper [2]. This index was used in [2] to measure the polarization level for SAH data. It was proved in [2] that the index POA verifies axioms that are characteristic to the bipolarization phenomenon for ordinal classes.

Using the previous notations, for variable X with four ordinal classes we have ([2], [4]):

$$POA(X) = 1 - (\,|\,2p_1 - 1\,|\, + \,|\,2p_1 + 2p_2 - 1\,|\, + \,|\,2p_1 + 2p_2 + 2p_3 - 1\,|\,)\,/\,3$$

Constructing indicators for measuring the inequality phenomenon supposes to mandatorily respect several axioms (Cowell & Kuga [5]). We mention in particular the work of Cowell ([7], 2011) regarding a detailed description of the properties of indexes for the inequality process. Cowell and Ebert discuss in [6] several approaches of the inequality process. Lately, Cowell and Flachaire suggest a class of indicators for inequality used for ordinal variables ([8], 2014).

The Gini indicator is the most popular coefficient used for measuring the inequality that exists in the distributions of discrete and continuous variables.. Giudici and Raffinetti extend the use of the Gini index for ordinal variables *X* ([9], 2011). In the following, we will denote by *IGO*(*X*) the value of the inequality coefficient Gini-Raffinetti applied to variable *X*. The papers [9] and [10] contain details regarding the construction of the coefficient *IGO* which is based on attributing ranks to the ordinal classes, creating in a later phase the Lorenz curve.

The values of indexes *Mean*, *POA* şi *IGO* regarding the 20 European countries which will be analyzed is synthesized in *Table 2.2.* In order to compute the means, we use different weights $\underline{s}$ associated with the ordinal groups.

Table 2.2. The values of the coefficients Mean, POA and IGO.

Nr.	Country	Abbv.	Mean values weights: 1, 2, 3, 4	Mean values weights: 1,4,9,16	Mean values weights: 2,4,8,16	*POA* index	IGO index
1	Bulgaria	BG	2.538	7.290	7.050	0.507	0.412
2	Switzerland	CH	3.130	10.347	9.861	0.343	0.428
3	Cyprus	CY	3.094	10.383	10.076	0.462	0.365
4	Spain	ES	2.955	9.251	8.692	0.294	0.427
5	Finland	FI	2.828	8.720	8.349	0.419	0.417
6	France	FR	2.959	9.511	9.151	0.427	0.399
7	United_Kingdom	GB	2.976	9.711	9.398	0.458	0.380
8	Georgia	GE	2.348	6.387	6.291	0.495	0.440
9	Germany	DE	2.817	8.675	8.304	0.420	0.411
10	Italy	IT	2.893	8.905	8.383	0.319	0.423
11	Moldova	MD	2.529	7.083	6.764	0.454	0.414
12	Netherlands	NL	2.906	9.079	8.645	0.377	0.421
13	Norway	NO	3.165	10.745	10.412	0.444	0.365
14	Poland	PL	2.589	7.551	7.313	0.508	0.420
15	Romania	RO	2.492	6.941	6.647	0.471	0.403
16	Russia	RU	2.363	6.198	5.968	0.410	0.449
17	Serbia	RS	2.608	7.658	7.423	0.510	0.422
18	Slovenia	SI	2.643	7.916	7.699	0.522	0.408
19	Sweden	SE	3.100	10.268	9.872	0.403	0.397
20	Ukraine	UA	2.433	6.581	6.301	0.465	0.418

3. Mean index

We denote by *X* the ordinal variable attached to the population's answers to question *Q1*. We consider three variants of scores $\underline{s}$ atributed to the four ordinal classes defining variable X. More precisely, we will use the following scores: $\underline{s}^{(1)} = (1, 2, 3, 4)$, $\underline{s}^{(2)} = (1, 4, 9, 16)$, $\underline{s}^{(3)} = (2, 4, 8, 16)$. So, a score k from the vector $\underline{s}^{(1)}$ becomes k^2 in the vector $\underline{s}^{(2)}$ and 2^k in $\underline{s}^{(3)}$.

We denote by X_t the ordinal variable that characterizes the distribution of answers to question *Q1* for the persons from country t , $1 \le t \le 20$. In *Fig. 3.1-3.3* we find the positions of the European countries in regard to the values of the indicator $Mean(X_t ; \underline{s}^{(j)})$, $1 \le t \le 20$, $j \in \{ 1 , 2 , 3 \}$. The values $Mean(X_t ; \underline{s}^{(j)})$ were already computed in *Table 2.2.*

Fig. 3.1. The position of the European countries t after $Mean(X_t\ ;\ \underline{s}^{(1)})$.

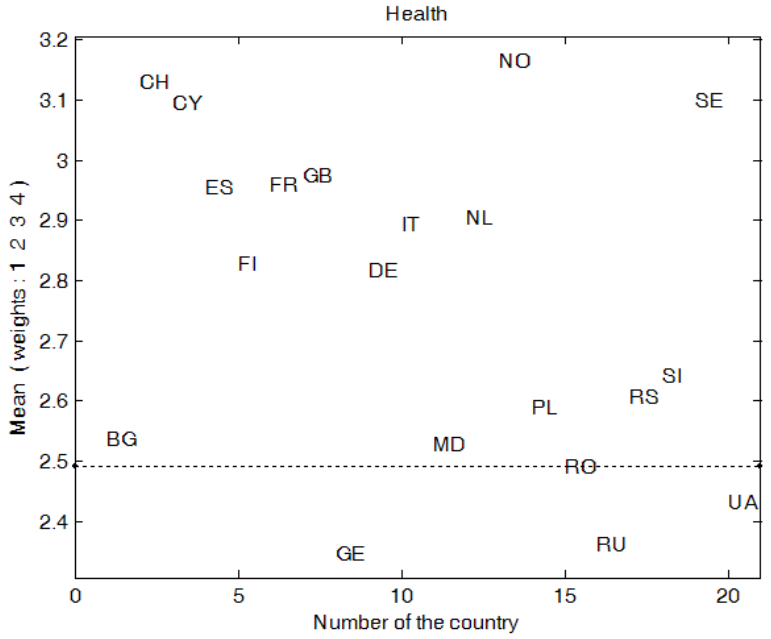


Fig. 3.2. The position of the European countries t after $Mean(X_t\ ;\ \underline{s}^{(2)})$.

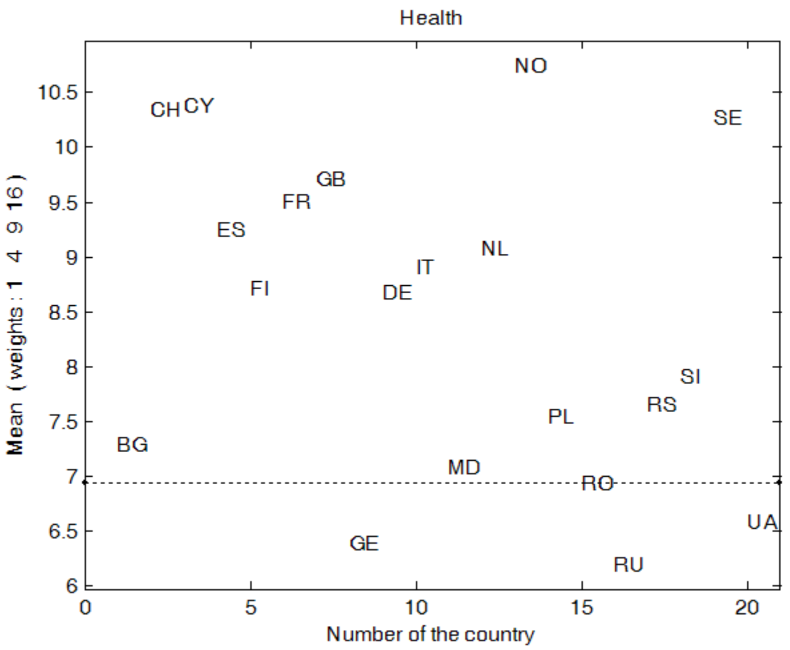
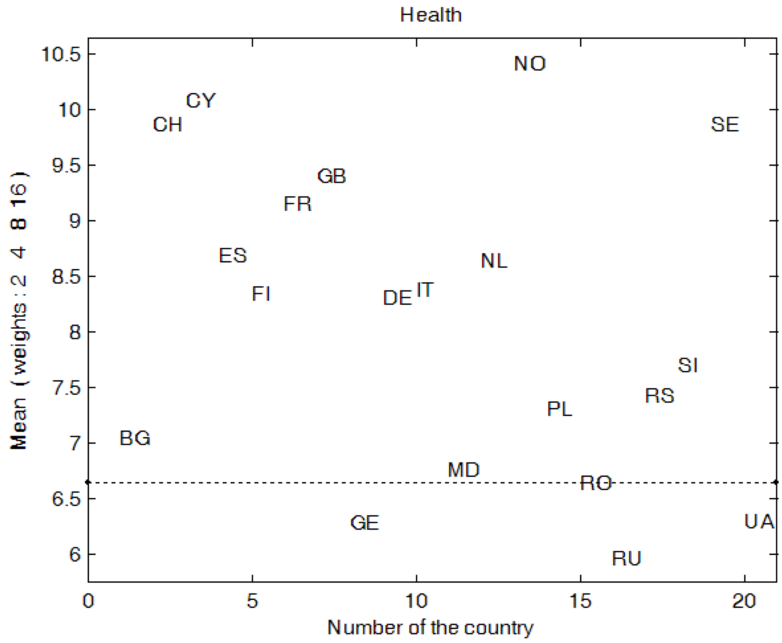


Fig. 3.3. The position of the European countries t after $Mean(X_t\ ;\ \underline{s}^{(3)})$.



Without having a linear relationship between the weights $\underline{s}^{(1)}$, $\underline{s}^{(2)}$, $\underline{s}^{(3)}$ attached to the ordinal classes of variables X_t and ignoring the measurement scale, we observe that *Fig. 3.1-3.3* are very similar. This may result from a structural similarity of the distributions of the answers in the European countries t, which are involved in the current statistical analysis. Theoretically, the means $Mean(X_t\ ;\ \underline{s}^{(j)})$ have, in general, distinct values compared with the used scores $\underline{s}^{(1)}$, $\underline{s}^{(2)}$, $\underline{s}^{(3)}$.

Considering the means $Mean(X_t\ ;\ \underline{s}^{(j)})$, $1 \le j \le 3$, *Tables 3.4-3.6* establish the hierarchy between the studied countries t, $1 \le t \le 20$.

Table 3.4. The hierarchy of the European countries t considering $Mean(X_t\ ;\ \underline{s}^{(1)})$.

Rank	1	2	3	4	5	6	7	8	9	10
Country	NO	CH	SE	CY	GB	FR	ES	NL	IT	FI
Mean	3.165	3.130	3.100	3.094	2.976	2.959	2.955	2.906	2.893	2.828
Rank	11	12	13	14	15	16	17	18	19	20
Country	DE	SI	RS	PL	BG	MD	RO	UA	RU	GE
Mean	2.817	2.643	2.608	2.589	2.538	2.529	2.492	2.433	2.363	2.348

Table 3.5. The hierarchy of the European countries t considering $Mean(X_t\ ;\ \underline{s}^{(2)})$.

Rank	1	2	3	4	5	6	7	8	9	10
Country	NO	CY	CH	SE	GB	FR	ES	NL	IT	FI
Mean	10.745	10.383	10.347	10.268	9.711	9.511	9.251	9.079	8.905	8.720
Rank	11	12	13	14	15	16	17	18	19	20
Country	DE	SI	RS	PL	BG	MD	RO	UA	GE	RU
Mean	8.675	7.916	7.658	7.551	7.290	7.083	6.941	6.581	6.387	6.198

Table 3.6. The hierarchy of the European countries t considering $Mean(X_t\ ;\ \underline{s}^{(3)})$.

Rank	1	2	3	4	5	6	7	8	9	10
Country	NO	CY	SE	CH	GB	FR	ES	NL	IT	FI
Mean	10.412	10.076	9.872	9.861	9.398	9.151	8.692	8.645	8.383	8.349
Rank	11	12	13	14	15	16	17	18	19	20
Country	DE	SI	RS	PL	BG	MD	RO	UA	GE	RU
Mean	8.304	7.699	7.423	7.313	7.050	6.764	6.647	6.301	6.291	5.968

Comparing *Tables 3.4-3.6* we observe the following:

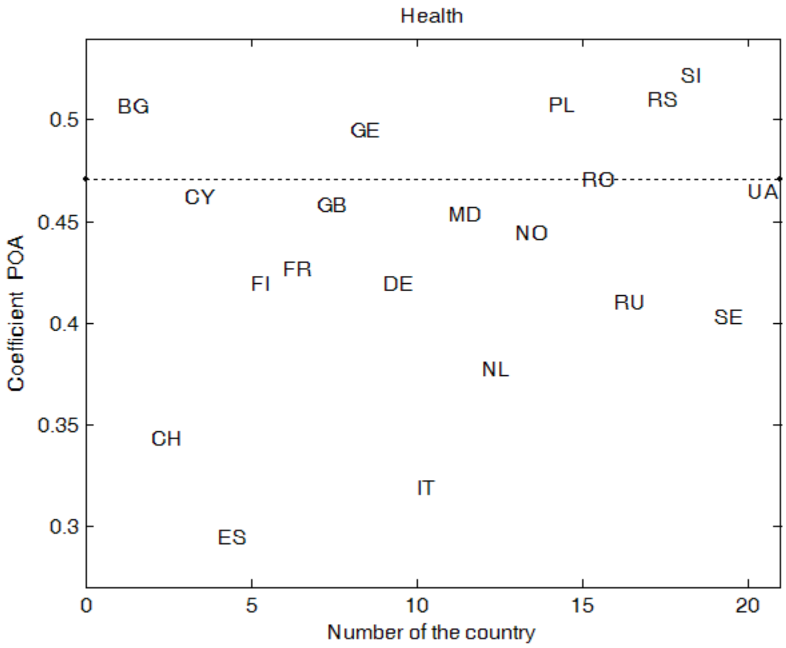
- The obtained hierarchies suffer small modifications in regard to the scores $\underline{s}^{(1)}$, $\underline{s}^{(2)}$, $\underline{s}^{(3)}$ which are attached to the ordinal classes. The classiffications which result are stable, usually maintaining the order between the countries.

- Romania is always situated on the 17th place out of the 20 countries considered. Georgia, Ukraine and Russia are the only countries that are situated below Romania from the point of view of the health status of their corresponding population. Bulgaria and Moldova have a slightly better position than Romania.
- Norway is on the first place in all three variants of scores $\underline{s}$.
- On the last place we find Russia, no matter what scores $\underline{s}$ are used.
- Regarding the different scores $\underline{s}$ attributed to the ordinal classes, the places 2-4 from the classification are divided between Cyprus, Sweden and Switzerland.
- The averages resulted from the three hierarchies differ sometimes significantly with respect to the scores $\underline{s}$.

4. Polarization coefficient

We will attempt to produce a hierarchization of the 20 European countries taking under account the polarization of answers from the population regarding the individual health status. Concretely, in *Fig 4.1* we represent graphically the position of the countries t , $1 \leq t \leq 20$, with respect to $POA(X_t)$ the degree of bipolarization of the ordinal variables X_t . The values of $POA(X_t)$ can be found in *Table 2.2*.

Fig. 4.1. The position of the European countries t using the values $POA(X_t)$.



Taking into account the polarization level of the population's answers we obtain in *Table 4.2* a new hierarchization of the European states.

Table 4.2. The hierarchy of the European countries t based on $POA(X_t)$.

Rank	1	2	3	4	5	6	7	8	9	10
Country	ES	IT	CH	NL	SE	RU	FI	DE	FR	NO
POA	0.294	0.319	0.343	0.377	0.403	0.410	0.419	0.420	0.427	0.444
Rank	11	12	13	14	15	16	17	18	19	20
Country	MD	GB	CY	UA	RO	GE	BG	PL	RS	SI
POA	0.454	0.458	0.462	0.465	0.471	0.495	0.507	0.508	0.510	0.522

Analyzing the graphical representation from *Fig. 4.1*, as well as the data from *Table 4.2*, we mention the following:

- The new hierarchy given by *Table 4*.2 differs significantly from the hierarchies in *Tables 3.4-3.6*.
- Taking into account, the polarization degree of answers to question *Q1* , Romania is situated on the 15th place. In the preceeding hierarchizations, Romania was on the 17th place.

- This time, besides Georgia, we find a polarization that is higher than Romania's in: Bulgaria, Poland, Serbia and Slovenia.
- From the studied countries, Slovenia presents the highest degree of polarization of the population's answers.
- Compared to the hierarchizations from *Tables 3.4-3.*6, in the new classification Russia and Ukraine have a lower polarization than România.
- The smallest polarization is found in Spain and Italy.
- Norway is on the 10th place when it comes to the polarization index. In the previous hierarchizations, which used the mean indicator, Norway was on the first place.
- Taking into account the mean criterion or the value of the bipolarization index, Romania is situated on an inferiour position, that is in the last quarter of the studied countries.

5. Inequality indicator

In this section, we will use a new coefficient of hierarchization, that is the inequality degree which is present in the answers of the population at question *Q1*.

Concretely, we will use for the hierarchization the values of the indicator *IGO* , which were presented in *Table 2.2*.

Fig. 5.1 gives us a suggestive graphical image regarding the positioning of the European countries with respect to the *IGO* level of inequality.

By making a synthetical presentation, *Table 5.2* suggests a hierachization of the 20 countries studied regarded the inequality appeared in the distribution of answers of the persons interviewed.

By interpreting *Fig. 5.1* and the data from *Table 5.2* we observe the following :

- The hierarchy based on the value of the indicator *IGO* of inequality differs significantly from all the previous classifications (to compare *Tables 3.4-3.6, 4.2* with *Table 5.2*).
- Regarding the level of inequality of the distribution of answers to question *Q1*, Romania has a top position, that is place 6 out of 20 countries. In the previous classifications, Romania had one of the last places.
- With an inequality coefficient smaller than Romania's, we find the following five countries: Cyprus, Norway, United Kingdom, France and Sweden.
- Cyprus is the country in which the inequality of the answers' distribution is the smallest.
- Georgia and Russia are positionned on the final two places regarding the inequality degree.
- Norway and Spain who were on the first place in the preceeding classifications are now on the 2nd place and 17 place respectively. A very small polarization in Spain is superposed over a very high inequality for the population's answers.
- This last classification based on the inequality phenomenon seems unrealistic in many situation. See for example the cases of Romania and Spain.
- When referring to the population's opinion regarding the individual health status, for many developed European countries like Germany, Switzland, Netherlands or Italy we notice a higher degree of inequality in the answers, compared to the perceived inequality in Romania. In this situation we must take into account that there are different standards and expectations from one country to the next.

Fig. 5.1. The position of the European countries t using the values $IGO(X_t)$.

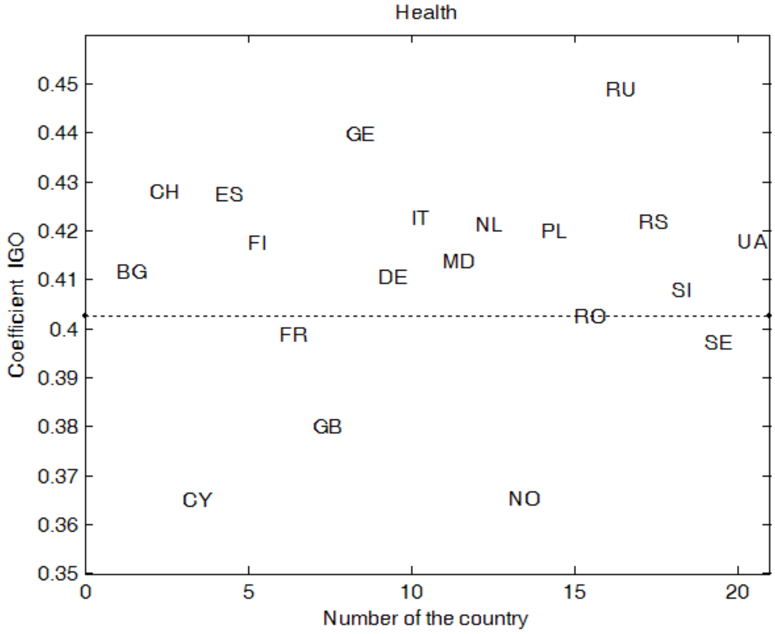


Table 5.2. The hierarchy of the European countries t based on $POA(X_t)$.

Rank	1	2	3	4	5	6	7	8	9	10
Country	CY	NO	GB	SE	FR	RO	SI	DE	BG	MD
IGO	0.365	0.365	0.380	0.397	0.399	0.403	0.408	0.411	0.412	0.414
Rank	11	12	13	14	15	16	17	18	19	20
Country	FI	UA	PL	NL	RS	IT	ES	CH	GE	RU
IGO	0.417	0.418	0.420	0.421	0.422	0.423	0.427	0.428	0.440	0.449

6. Final conclusions

We do not recommend for SAH data to be used the mean indicator, because in the case of ordinal variables the attribution of subjective scores $\underline{s}$ attached to the classes does not have a theoretical basis. In the situation that we have presented, there are no significant fluctuations in the ordering of the studied European countries. (*Table 3.4-3.6*). Romania is constantly on the 17th place out of the 20 countries.

Evidently, the resulting classification depends on the applied criterion (*Tables 3.4-3.6, 4.2, 5.2*) . We have used three indicators for the hierarchization of the European states, that are the following: evaluation index for the mean, polarization coefficient, inequality coefficient. (*Fig. 3.1-3.3, 4.1, 5.1*).

It is preferable that the countries hierarchization is not made by using a single criterion. The polarization and inequality criterion are distinct, a fact that is shown by the values of the indicators *POA* and *IGO* respectively (*Table 2.2*). In fact, the indicators *POA* and *IGO* are independent (Ştefănescu [10] , *Table 4.1* and *Graphic 4.2*). The hierarchization of the countries using separately the three indicators are sometimes very different (*Tables 3.4-3.6, 4.2 , 5.2*). This fact determines distinct positionings for Romania in regard to the used indicators.

In order to obtain a more precise classification, we propuse the simultaneous use of the two indicators *POA* and *IGO* by creating an aggregate indicator.

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