



EUROPEAN UNION MEMBER STATES' PERFORMANCE IN THE 2018 GLOBAL COMPETITIVENESS INDEX 4.0 THROUGH THE PRISM OF INTERCRITERIA ANALYSIS

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Abstract: *Every year, the World Economic Forum releases its Global Competitiveness Report, which assesses, according to twelve pillars, many variables that influence the performance of nations' economic competitiveness. The report aims to help nations identify which factors each nation's government needs to focus on to improve its innovation ecosystem. In the end of 2018, WEF restructured the methodology of its annual Global Competitiveness Index (GCI), now labeled "4.0", preserving some of their traditional twelve pillars of competitiveness, while changing others, not only nominally, but also in terms of their subindicators, derived from the databases of various international organizations and WEF itself. Having a history of research on data from the annual GCRs, using the intuitionistic fuzzy sets-based methodology of InterCriteria analysis, we are now challenged to research the InterCriteria performance of the redefined set of pillars, and compare the results of the 2018 GCR with those from previous years. InterCriteria Analysis is considered a useful tool as it outlines data-derived patterns of correlation in between the pillars, while rendering an account of the inherent uncertainty due to the use of intuitionistic fuzziness.*

1. INTRODUCTION

In the end of 2018, the World Economic Forum (WEF) restructured the methodology of its annual Global Competitiveness Index (GCI), now labeled "4.0" [25], preserving some of their traditional twelve pillars of competitiveness, while changing others, not only nominally, but also in terms of their sub-indicators, derived from the databases of various international organizations and WEF itself. As it states that the new GCI "integrates well-established aspects with new and emerging levers that drive productivity and growth. It emphasizes the role of human capital, innovation, resilience and agility, as not only drivers but also defining features of economic success in the [Fourth Industrial Revolution]".

After a series of research on both European and global level, using the instrumentation of the intuitionistic fuzzy sets-based InterCriteria analysis and the data from the annual Global Competitiveness Reports from 2007 to 2017 (see e.g. [11–14, 16] and [24]), we are now challenged to conduct the same research on the new data for the year 2018, and derive the respective conclusions. We are again focused on investigating the data for the European Union Member States.

2. THE METHOD OF INTERCRITERIA ANALYSIS

InterCriteria Analysis (ICA) was originally introduced in 2014 [8] as a method based on intuitionistic fuzzy sets [3–6] which receives as input datasets of the evaluations of multiple objects against multiple criteria and returns as output a table of detected dependencies in the form of intuitionistic fuzzy pairs [9] between each pair of criteria. These dependencies are interpreted as presence of pairwise correlation (termed positive consonance), lack of correlation (or, negative consonance), and uncertainty (i.e., dissonance). In the original problem formulation that leads to the idea of ICA, measuring against some of the criteria is slower or more expensive than measuring against others, and the decision maker's aim is to accelerate or lower the cost of the overall decision making process by eliminating the costly criteria on the basis of these existing correlations. The use of intuitionistic fuzzy pairs requires the introduction of two thresholds, respectively, for the membership and the non-membership part of the IFP [9], which is to ensure that the precision of the decision taken is not compromised by uncertainty. A detailed presentation of the method is given in [7, 8], and of the various ways of defining these thresholds are presented in [19]. For the reader's convenience we will repeat here the basic presentation of the ICA method from [19].

The ICA method is based on two fundamental concepts: intuitionistic fuzzy sets and index matrices. Intuitionistic fuzzy sets defined by Atanassov (see [3–6]) represent an extension of the concept of fuzzy sets, as defined by Zadeh [26], exhibiting function $\mu_A(x)$ defining the membership of an element x to the set A , evaluated in the $[0; 1]$ -interval. The difference between fuzzy sets and intuitionistic fuzzy sets (IFSSs) is in the presence of a second function $\nu_A(x)$ defining the non-membership of the element x to the set A , where $\mu_A(x) \in [0; 1]$, $\nu_A(x) \in [0; 1]$, and moreover $(\mu_A(x) + \nu_A(x)) \in [0; 1]$.

The second concept on which the proposed method relies is the concept of index matrix, a matrix which features two index sets. The theory behind the index matrices is originally described in

[1] and elaborated in details in [2]. Here we will start with the index matrix M with index sets with m rows $\{C_1, \dots, C_m\}$ and n columns $\{O_1, \dots, O_n\}$:

$$M = \begin{array}{c|cccccc} & O_1 & \dots & O_k & \dots & O_l & \dots & O_n \\ \hline C_1 & a_{C_1, O_1} & \dots & a_{C_1, O_k} & \dots & a_{C_1, O_l} & \dots & a_{C_1, O_n} \\ \vdots & \vdots & \ddots & \vdots & \ddots & \vdots & \ddots & \vdots \\ C_i & a_{C_i, O_1} & \dots & a_{C_i, O_k} & \dots & a_{C_i, O_l} & \dots & a_{C_i, O_n} \\ \vdots & \vdots & \ddots & \vdots & \ddots & \vdots & \ddots & \vdots \\ C_j & a_{C_j, O_1} & \dots & a_{C_j, O_k} & \dots & a_{C_j, O_l} & \dots & a_{C_j, O_n} \\ \vdots & \vdots & \ddots & \vdots & \ddots & \vdots & \ddots & \vdots \\ C_m & a_{C_m, O_1} & \dots & a_{C_m, O_j} & \dots & a_{C_m, O_l} & \dots & a_{C_m, O_n} \end{array},$$

where for every p, q ($1 \leq p \leq m, 1 \leq q \leq n$), C_p is a criterion (in our case, one of the twelve pillars), O_q in an evaluated object (in our case, one of the EU28 member states), $a_{C_p O_q}$ is the evaluation of the q -th object against the p -th criterion, and it is defined as a real number or another object that is comparable according to relation R with all the rest elements of the index matrix M , so that for each i, j, k it holds the relation $R(a_{C_k O_i}, a_{C_k O_j})$. The relation R has dual relation \bar{R} , which is true in the cases when relation R is false, and vice versa.

For the needs of our method, pairwise comparisons between every two different criteria are made along all evaluated objects. During the comparison, it is maintained one counter of the number of times when the relation R holds, and another counter for the dual relation. Let $S_{k,l}^\mu$ be the number of cases where the relations $R(a_{C_k O_i}, a_{C_k O_j})$ and $R(a_{C_l O_i}, a_{C_l O_j})$ are simultaneously satisfied. Let also $S_{k,l}^\nu$ be the number of cases in which the relations $R(a_{C_k O_i}, a_{C_k O_j})$ and its dual $\bar{R}(a_{C_l O_i}, a_{C_l O_j})$ are simultaneously satisfied. As the total number of pairwise comparisons between the object is $n(n-1)/2$, it is seen that there hold the inequalities:

$$0 \leq S_{k,l}^\mu + S_{k,l}^\nu \leq \frac{n(n-1)}{2}.$$

For every k, l , such that $1 \leq k \leq l \leq m$, and for $n \geq 2$ two numbers are defined:

$$\mu_{C_k, C_l} = 2 \frac{S_{k,l}^\mu}{n(n-1)}, \quad \nu_{C_k, C_l} = 2 \frac{S_{k,l}^\nu}{n(n-1)}.$$

The pair constructed from these two numbers plays the role of the intuitionistic fuzzy evaluation of the relations that can be established between any two criteria C_k and C_l . In this way the index matrix M that relates evaluated objects with evaluating criteria can be transformed to another index matrix M^* that gives the relations among the criteria:

$$M^* = \begin{array}{c|ccc} & C_1 & \dots & C_m \\ \hline C_1 & \langle \mu_{C_1, C_1}, \nu_{C_1, C_1} \rangle & \dots & \langle \mu_{C_1, C_m}, \nu_{C_1, C_m} \rangle \\ \vdots & \vdots & \ddots & \vdots \\ C_m & \langle \mu_{C_m, C_1}, \nu_{C_m, C_1} \rangle & \dots & \langle \mu_{C_m, C_m}, \nu_{C_m, C_m} \rangle \end{array}.$$

The final step of the algorithm is to determine the degrees of correlation between the criteria, depending on the user's choice of μ and ν . We call these correlations between the criteria:

‘positive consonance’, ‘negative consonance’ or ‘dissonance’.

Let $\alpha, \beta \in [0; 1]$ be given, so that $\alpha + \beta \leq 1$. We say that criteria C_k and C_l are in:

- (α, β) -positive consonance, if $\mu_{C_k, C_l} > \alpha$ and $v_{C_k, C_l} < \beta$;
- (α, β) -negative consonance, if $\mu_{C_k, C_l} < \beta$ and $v_{C_k, C_l} > \alpha$;
- (α, β) -dissonance, otherwise, [8].

Obviously, the larger α and/or the smaller β , the less number of criteria may be simultaneously connected with the relation of (α, β) -positive consonance. For practical purposes, it carries the most information when either the positive or the negative consonance is as large as possible, since the cases of dissonance are less to no informative.

3. INPUT DATA

The input data comes in the form of a matrix of 28 labelled rows staying for the analysed European Union member states and 12 labelled columns for the pillars of competitiveness in the new GCI methodology, see Table 1. For comparison, on Table 2 is given the Global Competitiveness Index framework from the previous GCI methodology. One of the changes in the new methodology is that the evaluations of countries against the pillars of competitiveness (see Table 3) are numbers in the 0-100 range (100 being best), instead of the 1-7 range. We can immediately note that from the ICA point of view, this more detailed range means potentially lower uncertainty in the results of the ICA analysis (see [17]).

Enabling environment				Human capital		Markets				Innovation ecosystem	
1. Institutions	2. Infrastructure	3. ICT adoption	4. Macroeconomic stability	5. Health	6. Skills	7. Product market	8. Labour market	9. Financial system	10. Market size	11. Business dynamism	12. Innovation capability

Table 1. The pillars of competitiveness in the GCI 4.0 (2018)

Basic requirements				Efficiency enhancers						Innovation and sophistication factors	
1. Institutions	2. Infrastructure	3. Macroeconomic stability	4. Health and primary education	5. Higher education and training	6. Goods market efficiency	7. Labour market efficiency	8. Financial market development	9. Technological readiness	10. Market size	11. Business sophistication	12. Innovation

Table 2. The pillars of competitiveness in the GCI (up to 2017)

	1. Institutions	2. Infrastructure	3. ICT adoption	4. Macroeconomic stability	5. Health	6. Skills	7. Product market	8. Labour market	9. Financial system	10. Market size	11. Business dynamism	12. Innovation capability
Austria	72.7	88.3	64.7	100	96.7	78.4	66.5	67.3	72.9	64.3	69.9	74.3
Belgium	69.8	86.5	66.1	100	94.1	79.5	64.3	64.4	78.4	68.9	73.8	73.4
Bulgaria	53.6	69.9	69.6	89.2	80	64.7	56.7	62	58.2	54.6	60.3	43.9
Croatia	52	76.8	60.2	69.3	85.7	63.4	55.7	54.8	60.6	49.5	55.7	37.7
Cyprus	63	74.9	68.8	78.9	94.4	72.8	63.3	66.9	53.3	39.1	66.9	44.7
Czechia	60.5	83.5	65.7	100	87.8	73.7	60.4	63	67.5	64.6	70.2	57.3
Denmark	75.9	86.3	82.3	100	93.4	84.9	66.9	78	85.8	59.6	79.1	75.4
Estonia	69.5	75.2	77.4	100	84.9	78	64.8	69.3	65.9	42.3	69.3	52.5
Finland	81	82.3	77	100	95.4	87.9	66.9	70.9	89.7	57.4	78.3	76.3
France	69.5	90.1	71.1	99.9	99.1	72.6	62.5	61.5	82.9	81.5	69.4	76.1
Germany	73.5	90.2	69.3	100	94.5	85.4	72	74.1	80.2	85.8	81.6	87.5
Greece	50.5	76.2	58.9	73.6	95.7	70.4	56.7	51.8	49.4	59	58	45
Hungary	54.2	78.4	61	90	80.7	68.5	54.4	57.8	59.8	61.7	57.2	48
Ireland	73.1	77	66	99.4	95.1	79.9	64.2	76.8	68.5	64	76.9	67
Italy	56.4	83.1	60.3	85	99.2	70.1	62.6	58.1	64.3	79.1	65.4	65.8
Latvia	57.9	73.1	80.4	100	78.8	74.5	59.8	66.8	53.5	44	64.3	42
Lithuania	60.9	74.7	75.8	100	78.8	73.3	57.7	65.2	56.9	50.1	64.5	47.4
Luxembourg	75.2	84.7	74.8	100	96.8	74.7	69.3	73.7	86.5	50	65.8	68.2
Malta	63.5	71.7	72.4	100	96.6	72.4	61.5	67.8	72.2	36.7	59.2	51
Netherlands	77.9	92.4	75.1	100	96	84.5	72.3	74.9	83.7	73.9	80.3	77.5
Poland	57.1	79.3	54.4	100	86.2	72.9	61.2	59.8	63.4	73.4	61.5	48.7
Portugal	63.9	83.3	67.1	85	95.3	69.9	61.9	64.7	68.4	60.1	69.7	53.1
Romania	58.1	71.2	67.1	89.2	79.8	61.8	57.3	60.7	51.9	64.7	60.1	39.6
Slovakia	56.4	77.6	67.8	99.9	84	68.6	55	60.2	63.7	57.7	64.5	46.6
Slovenia	63.1	76.9	65.6	100	91.6	73.5	63.1	63.4	62.3	47.8	70.3	57.9
Spain	64.5	89.1	73.8	90	100	70.7	62	59.5	75.1	76.7	66.3	62.9
Sweden	76	84.4	85.2	100	96.5	84.2	68.8	71.1	89	65.1	79.8	79.8
UK	76.8	89	71.1	100	93.9	80.2	68.7	76.5	87.8	81.7	79	79.2

Table 3. Data derived from the GCI 4.0 about the 28 EU member states.
The evaluations are numbers in the 0-100 range and herewith conditionally formatted.

4. MAIN RESULTS AND DISCUSSION

The input data from Table 3 were analysed using the software for InterCriteria Analysis, developed by D. Mavrov [20–22], available as open source code [27]. The output represents two 12×12 tables (matrices), for the membership (μ) and the non-membership parts (ν) of the intuitionistic fuzzy pairs that stand collectively for the intuitionistic fuzzy consonance / dissonance between each pair of criteria. Both matrices are symmetrical according to the main diagonal, as in the ICA method the InterCriteria consonance between criteria C_i and C_j is identical with the InterCriteria consonance between C_j and C_i . Also, along the main diagonal all the elements are the IFPs $\langle 1,0 \rangle$, since every criterion correlates with itself perfectly.

On Table 4 we present the ICA results showing the membership and the non-membership parts of the InterCriteria pairwise correlations.

μ	Pillar 1	Pillar 2	Pillar 3	Pillar 4	Pillar 5	Pillar 6	Pillar 7	Pillar 8	Pillar 9	Pillar 10	Pillar 11	Pillar 12
Pillar 1	1.000	0.717	0.706	0.534	0.648	0.825	0.860	0.831	0.841	0.582	0.828	0.828
Pillar 2	0.717	1.000	0.532	0.431	0.714	0.688	0.717	0.611	0.775	0.780	0.743	0.825
Pillar 3	0.706	0.532	1.000	0.495	0.508	0.667	0.646	0.722	0.675	0.439	0.624	0.603
Pillar 4	0.534	0.431	0.495	1.000	0.333	0.571	0.511	0.529	0.511	0.354	0.503	0.513
Pillar 5	0.648	0.714	0.508	0.333	1.000	0.579	0.669	0.550	0.717	0.616	0.606	0.709
Pillar 6	0.825	0.688	0.667	0.571	0.579	1.000	0.815	0.807	0.765	0.569	0.841	0.799
Pillar 7	0.860	0.717	0.646	0.511	0.669	0.815	1.000	0.802	0.783	0.598	0.836	0.841
Pillar 8	0.831	0.611	0.722	0.529	0.550	0.807	0.802	1.000	0.709	0.476	0.770	0.712
Pillar 9	0.841	0.775	0.675	0.511	0.717	0.765	0.783	0.709	1.000	0.646	0.767	0.860
Pillar 10	0.582	0.780	0.439	0.354	0.616	0.569	0.598	0.476	0.646	1.000	0.646	0.712
Pillar 11	0.828	0.743	0.624	0.503	0.606	0.841	0.836	0.770	0.767	0.646	1.000	0.841
Pillar 12	0.828	0.825	0.603	0.513	0.709	0.799	0.841	0.712	0.860	0.712	0.841	1.000

ν	Pillar 1	Pillar 2	Pillar 3	Pillar 4	Pillar 5	Pillar 6	Pillar 7	Pillar 8	Pillar 9	Pillar 10	Pillar 11	Pillar 12
Pillar 1	0.000	0.278	0.283	0.132	0.344	0.169	0.130	0.164	0.153	0.413	0.164	0.167
Pillar 2	0.278	0.000	0.463	0.241	0.283	0.312	0.278	0.389	0.225	0.220	0.254	0.175
Pillar 3	0.283	0.463	0.000	0.172	0.484	0.328	0.344	0.272	0.320	0.556	0.368	0.392
Pillar 4	0.132	0.241	0.172	0.000	0.341	0.101	0.161	0.143	0.161	0.317	0.167	0.159
Pillar 5	0.344	0.283	0.484	0.341	0.000	0.418	0.323	0.447	0.280	0.381	0.389	0.288
Pillar 6	0.169	0.312	0.328	0.101	0.418	0.000	0.180	0.193	0.235	0.431	0.156	0.201
Pillar 7	0.130	0.278	0.344	0.161	0.323	0.180	0.000	0.193	0.212	0.397	0.156	0.153
Pillar 8	0.164	0.389	0.272	0.143	0.447	0.193	0.193	0.000	0.291	0.524	0.228	0.288
Pillar 9	0.153	0.225	0.320	0.161	0.280	0.235	0.212	0.291	0.000	0.354	0.230	0.140
Pillar 10	0.413	0.220	0.556	0.317	0.381	0.431	0.397	0.524	0.354	0.000	0.352	0.288
Pillar 11	0.164	0.254	0.368	0.167	0.389	0.156	0.156	0.228	0.230	0.352	0.000	0.156
Pillar 12	0.167	0.175	0.392	0.159	0.288	0.201	0.153	0.288	0.140	0.288	0.156	0.000

Table 4. Results of the InterCriteria Analysis from the input of Table 3.



C_i	C_j	μ	ν	d
Pillar 1	Pillar 7	0.860	0.130	0.191
Pillar 9	Pillar 12	0.860	0.140	0.198
Pillar 1	Pillar 9	0.841	0.153	0.221
Pillar 7	Pillar 12	0.841	0.153	0.221
Pillar 6	Pillar 11	0.841	0.156	0.223
Pillar 11	Pillar 12	0.841	0.156	0.223
Pillar 7	Pillar 11	0.836	0.156	0.226
Pillar 1	Pillar 8	0.831	0.164	0.236
Pillar 1	Pillar 11	0.828	0.164	0.238
Pillar 1	Pillar 12	0.828	0.167	0.239
Pillar 1	Pillar 6	0.825	0.169	0.243
Pillar 2	Pillar 12	0.825	0.175	0.247
Pillar 6	Pillar 7	0.815	0.180	0.258
Pillar 6	Pillar 8	0.807	0.193	0.273
Pillar 7	Pillar 8	0.802	0.193	0.277
Pillar 6	Pillar 12	0.799	0.201	0.284
Pillar 7	Pillar 9	0.783	0.212	0.303
Pillar 2	Pillar 10	0.780	0.220	0.311
Pillar 2	Pillar 9	0.775	0.225	0.318
Pillar 8	Pillar 11	0.770	0.228	0.324
Pillar 9	Pillar 11	0.767	0.230	0.327
Pillar 6	Pillar 9	0.765	0.235	0.333
Pillar 2	Pillar 11	0.743	0.254	0.361
Pillar 3	Pillar 8	0.722	0.272	0.389
Pillar 1	Pillar 2	0.717	0.278	0.397
Pillar 2	Pillar 7	0.717	0.278	0.397
Pillar 5	Pillar 9	0.717	0.280	0.398
Pillar 2	Pillar 5	0.714	0.283	0.402
Pillar 8	Pillar 12	0.712	0.288	0.408
Pillar 10	Pillar 12	0.712	0.288	0.408
Pillar 1	Pillar 3	0.706	0.283	0.408
Pillar 5	Pillar 12	0.709	0.288	0.410
Pillar 8	Pillar 9	0.709	0.291	0.412

C_i	C_j	μ	ν	d
Pillar 4	Pillar 6	0.571	0.101	0.440
Pillar 2	Pillar 6	0.688	0.312	0.441
Pillar 3	Pillar 9	0.675	0.320	0.456
Pillar 5	Pillar 7	0.669	0.323	0.462
Pillar 3	Pillar 6	0.667	0.328	0.468
Pillar 1	Pillar 4	0.534	0.132	0.484
Pillar 1	Pillar 5	0.648	0.344	0.492
Pillar 4	Pillar 8	0.529	0.143	0.492
Pillar 3	Pillar 7	0.646	0.344	0.494
Pillar 10	Pillar 11	0.646	0.352	0.499
Pillar 9	Pillar 10	0.646	0.354	0.501
Pillar 4	Pillar 12	0.513	0.159	0.512
Pillar 4	Pillar 7	0.511	0.161	0.515
Pillar 4	Pillar 9	0.511	0.161	0.515
Pillar 4	Pillar 11	0.503	0.167	0.525
Pillar 3	Pillar 11	0.624	0.368	0.526
Pillar 3	Pillar 4	0.495	0.172	0.534
Pillar 5	Pillar 10	0.616	0.381	0.541
Pillar 2	Pillar 8	0.611	0.389	0.550
Pillar 5	Pillar 11	0.606	0.389	0.554
Pillar 3	Pillar 12	0.603	0.392	0.557
Pillar 7	Pillar 10	0.598	0.397	0.565
Pillar 1	Pillar 10	0.582	0.413	0.587
Pillar 5	Pillar 6	0.579	0.418	0.593
Pillar 6	Pillar 10	0.569	0.431	0.610
Pillar 2	Pillar 4	0.431	0.241	0.618
Pillar 5	Pillar 8	0.550	0.447	0.634
Pillar 2	Pillar 3	0.532	0.463	0.658
Pillar 3	Pillar 5	0.508	0.484	0.690
Pillar 4	Pillar 10	0.354	0.317	0.719
Pillar 8	Pillar 10	0.476	0.524	0.741
Pillar 4	Pillar 5	0.333	0.341	0.749
Pillar 3	Pillar 10	0.439	0.556	0.789

Table 5. The results of the InterCriteria Analysis from the input of Table 3, as sorted by Distance to 'Truth' (column d), calculated as Euclidean distance

On Figure 1 the graphical visualization of the ICA results is given, where each pair of criteria (of 66 in total) is plotted as a point on the intuitionistic fuzzy interpretational triangle with the membership and non-membership values of the InterCriteria relation serving as coordinates [10, 18, 22]. Those close to or on the hypotenuse mean very low to no uncertainty, hence the non-membership values are almost everywhere complementary to 1 to the respective membership ones. We immediately notice the cluster of points in the middle of the triangle, which corresponds to the ICA relations formed between Pillar 4 with all the other eleven pillars.

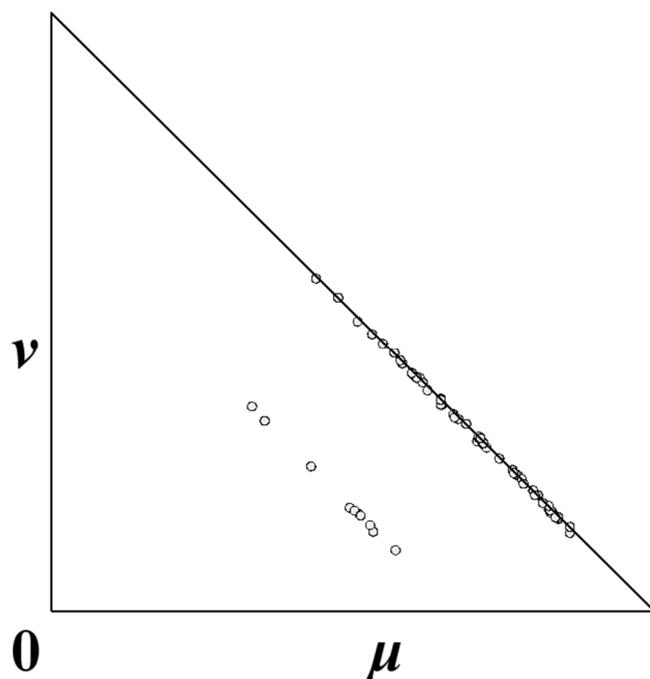


Figure 1. The intuitionistic fuzzy interpretational triangle with the results of the application of ICA from Table 4 plotted as points, each corresponding to a pair of criteria.

From the Top 10 percent of the results (well visible from Table 5) we notice some strong positive consonances among some of the pillars: Pillar 1 ‘Institutions’ and Pillar 7 ‘Product market’ with $\langle 0.860; 0.130 \rangle$, Pillar 9 ‘Financial system’ and Pillar 12 ‘Innovation capability’ with $\langle 0.860; 0.140 \rangle$, Pillar 1 ‘Institutions’ and Pillar 9 ‘Financial system’ with $\langle 0.841; 0.153 \rangle$, Pillar 7 ‘Product market’ and Pillar 12 ‘Innovation capability’ with $\langle 0.841; 0.153 \rangle$, Pillar 6 ‘Skills’ and Pillar 11 ‘Business dynamism’ with $\langle 0.841; 0.156 \rangle$, Pillar 11 ‘Business dynamism’ and Pillar 12 ‘Innovation capability’ with $\langle 0.841; 0.156 \rangle$, and Pillar 7 ‘Product market’ and Pillar 11 ‘Business dynamism’ with $\langle 0.836; 0.156 \rangle$. With some high enough positive consonances from the runners-up to the Top 10, we see that in addition to the ICA pairs, some ICA triples are also formed on the basis of strong positive consonance between triples of criteria (for ICA triples, see [15, 23]).

The Top 10 shows a strong bond between the Pillar 1 ‘Institutions’, Pillar 7 ‘Product market’, Pillar 9 ‘Financial system’ and Pillar 12 ‘Innovation capability’. Surprisingly, taking into account the results of the ICA application on the data from the GCI until 2018 (version 3.0) the

relation between Pillar 11 ‘Business dynamism’ and Pillar 12 ‘Innovation capability’ is not anymore the strongest one, as it traditionally used to be the case with the then pillars 11 ‘Business sophistication’ and 12 ‘Innovation’. In general, Pillars 1, 7, 12 are the best presented among the strongest positive consonances, with Pillars 9 and 11 coming next.

For comparison, the strongest negative consonances are formed in pairs containing Pillar 3 ‘ICT adoption’, Pillar 4 ‘Macroeconomic stability’, Pillar 5 ‘Health’ and Pillar 10 ‘Market size’. Especially concerning pillars 4 and 10, this is not surprising given that in the previous GCI methodology [24] they were also among the worst performing in terms of ICA consonance, and this observation repeats despite the significant changes in the subindicators on which basis these pillars are constructed.

6. CONCLUSIONS

The new methodology of the Global Competitiveness Index of the World Economic Forum, labelled 4.0 [25], which is in use as of the year 2018, has changed not only nominally but in some cases structurally the pillars of competitiveness against which every national economy in the world is being evaluated. While these changes do not allow us to make immediate comparisons between the new and the old methodology, the results of the application of the InterCriteria Analysis on the set of the European Union Member States for 2018 shows certain continuity of the observations with those from previous years with respect to the factors in the national economies that have the capacity of transformative forces, which need to be identified and strengthened in order to drive the future innovation capability and economic growth. The use of the intuitionistic fuzzy sets-based InterCriteria Analysis in this research as a tool for outlining these data-derived patterns of correlation among the pillars of competitiveness was considered appropriate for its ability to render an account of the inherent uncertainty which takes places in the socio-economic processes.

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