

InterCriteria Analysis of the Global Competitiveness Reports: From Efficiency- to Innovation-driven Economies

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Accepted: May 20, 2018.

Intercriteria analysis is applied here to data retrieved from the World Economic Forum's Global Competitiveness Reports from 2013–2014 to 2017–2018 about the set of countries in the world, which stage of economic development is in the transition from efficiency-driven to innovation-driven. We analyse data in search of correlations between the twelve pillars of competitiveness across, we outline and comment the findings, comparing them with results from our previous research performed over the member states of the European Union. What is specific in the application of ICA here is that we work with a set of elements (countries), whose belongingness to the set depends on their performance according to the set of criteria, and the set of objects varies over the years, although there are some core countries that regularly appear in the set. This however gives rise to a discussion about the comparability of the ICA results, and sheds light on both the method and the analysed set of countries.

Keywords: Intercriteria analysis, intuitionistic fuzzy sets, correlation, competitiveness, global competitiveness report, efficiency-driven economy, innovation-driven economy, world economic forum.

1 INTRODUCTION

The World Economic Forum (WEF) defines competitiveness as the set of institutions, policies, and factors that determine the level of productivity of a country. The level of productivity, in turn, sets the level of prosperity that can be reached by an economy, and defines the rates of return obtained by investments in an economy, which in turn are the fundamental drivers of its growth rates. This said, the more competitive economies are those that are likely to grow faster over time. WEF captures these trends by including in the Global Competitiveness Index (GCI) a weighted average of many different components, each measuring a different aspect of competitiveness. The components are grouped into 12 indexes, called “pillars of competitiveness”: 1. Institutions; 2. Infrastructure; 3. Macroeconomic environment; 4. Health and primary education; 5. Higher education and training; 6. Goods market efficiency; 7. Labor market efficiency; 8. Financial market development; 9. Technological readiness; 10. Market size; 11. Business sophistication; 12. Innovation.

Although all of the pillars matter to a certain extent for all economies, they affect different economies in different ways. In line with well-known economic theory of stages of development, the GCI assumes that, in the first stage, the economy is *factor-driven* and countries compete based on their factor endowments — primarily unskilled labor and natural resources. Competitiveness at this stage of development is primarily maintained due to well-functioning institutions (1st pillar), a well-developed infrastructure (2nd pillar), a stable macroeconomic environment (3rd pillar), and a healthy workforce that has received at least a basic education (4th pillar).

As a country becomes more competitive, with increased productivity and wages, it moves into the *efficiency-driven* stage of development, when it must begin to develop more-efficient production processes and increase product quality. At this point, competitiveness is increasingly driven by higher education and training (5th pillar), efficient goods markets (6th pillar), well-functioning labor markets (7th pillar), developed financial markets (8th pillar), the ability to harness the benefits of existing technologies (9th pillar), and a large domestic or foreign market (10th pillar).

Finally, as countries move into the *innovation-driven* stage, the ability to sustain higher wages and the associated standard of living is only possible if their businesses are able to compete using the most sophisticated production processes (11th pillar) and by developing new and innovative ones (12th pillar).

The GCI takes the stages of development into account by attributing higher relative weights to those pillars that are more relevant for an economy given its particular stage of development. To implement this concept,

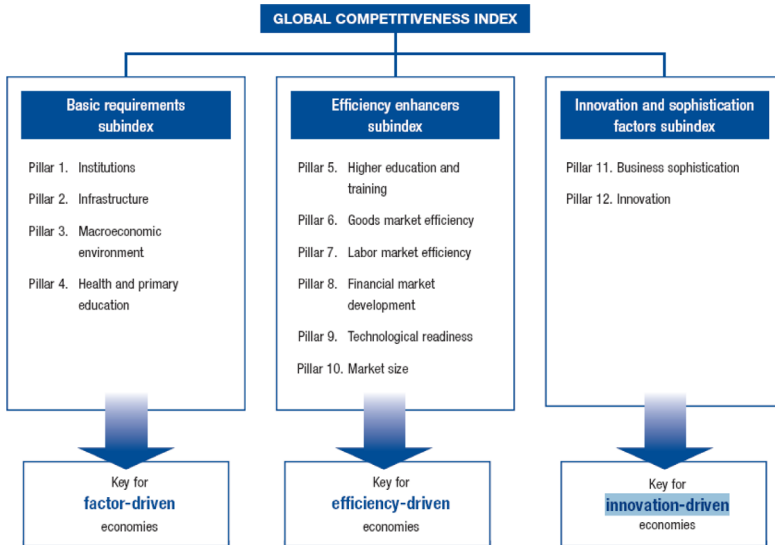


FIGURE 1
The Global Competitiveness Index framework, [16, p. 12]

the pillars are organized into three subindexes (groups), each critical to a particular stage of development. Any countries falling between two of the three stages are considered to be “in transition.” For these countries, the weights change smoothly as a country develops, reflecting the smooth transition from one stage of development to another, [14, p.37].

In the 2015–2016 GCR we read: “*Although we report the results of the 12 pillars of competitiveness separately, it is important to keep in mind that they are not independent: they tend to reinforce each other, and a weakness in one area often has a negative impact in others.*” [14, p. 37]. And in the 2013(2014 GCR there is an address to policymakers to “*identify and strengthen the transformative forces that will drive future economic growth*” [12, p. XIII]. This is an evidence that it is worth researching the interrelation of the 12 pillars, since it can give us better understanding and knowledge of the processes, driving economies forward, and as an appropriate tool for researching this interrelation, we use the apparatus of InterCriteria Analysis.

2 INTERCRITERIA ANALYSIS

The method of InterCriteria Analysis (ICA) was developed in 2014 [1] with the aim to address problems where on the basis of the numerical evaluations (measurements) of a set of objects against a set of criteria, levels of

correlation among the criteria can be detected, and in case of sufficiently high levels between certain pairs of criteria, respective decisions can be potentially made by the decision maker. It is a completely data-driven approach, which however renders an account of the degrees of uncertainty, which real life problems inherently exhibit.

The first problem, for which ICA was original constructed, using the paradigm of intuitionistic fuzzy sets, was a problem from the petrochemical industry, where a set of crude oil probes are measured against a set of chemical and physical parameters, but some of these measurements are expensive, time-consuming, and in other ways “unfavourable” compared to others which are fast, cheap, and possible sufficiently high, repetitively appearing correlations between the cost-unfavourable and cost-favourable criteria may help the business decision makers to skip at least part of all measurements of the crude oil probes.

Translating this industry problem to mathematical language, in terms of intuitionistic fuzzy sets [1], a method was devised based on the complete pairwise comparison of the values of all objects against all criteria, by maintaining three counters for the cases when every two pairs of values exhibit the same relation (e.g. “greater than”), or its inverse (resp., “less than”), or the complementary “equal”, with subsequent normalization in the $[0, 1]$ interval and interpretation of these counters as intuitionistic fuzzy pairs. The correlations between every pair from the set of criteria (from where the term: *intercriteria*) is interpreted in the form of an intuitionistic fuzzy pair [2], consisting of two numbers in the $[0, 1]$ interval, which sum is also a number in the same interval. Whether a detected ICA correlation is sufficiently high, or not, is a matter of additional discussions, and is completely

Soon after this mathematical interpretation of the particular problem was given, it was seen that the method is applicable to a wide range of other areas, with a variety of problem statements, and since then approbated in areas like economics, biochemistry, medicine, ecology, optimization of neural networks design, metaheuristics, etc.

3 PRESENTATION OF THE INPUT DATA

From the data in the GCR 2013–2014 [12, p. 11], GCR 2014–2015 [13, p. 11], GCR 2015–2016 [14, p. 38], GCR 2016–2017 [15, p. 38], GCR 2017–2028 [16, p. 320], we observe certain dynamics in the distribution of the analyzed countries across the stages, which can be visualized by the following Table 1:

While the numbers in the table are generally similar, the countries behind these numbers change over the years, especially in the two transition phases.

Year	Stage 1: Factor-driven	Transition stage 1-to-2	Stage 2: Efficiency-driven	Transition stage 2-to-3	Stage 3: Innovation-driven
2013–2014	38	20	31	22	37
2014–2015	37	16	30	24	37
2015–2016	35	16	31	20	38
2016–2017	35	17	30	19	37
2017–2018	35	15	31	20	36

TABLE 1

Comparison of the distribution of global economies per stages of economic development [12–16]

In the transition between Stages 2 and 3, we have Argentina, Chile, Costa Rica, Croatia, Hungary, Latvia, Lebanon, Lithuania, Mexico, Oman, Panama, Poland, Turkey and Uruguay being constantly exhibited in this category, with other countries entering the group (like Mauritius) or leaving it (like Brazil or Kazakhstan), or sporadically appearing in it. This shows the dynamism of this transition group, and makes it even more important for the results of the ICA method applied to these data to be compared at a next step of research to the results of its application to the data about the countries from neighbouring Stage 2 and Stage 3.

From the point of view of the methodology of application of the ICA method, this observation gives rise to a new consideration about the selection of objects in the input set. Since the method is completely data driven, the results from its application are completely dependent on the input data (i.e. the evaluations of objects against criteria), but all the more dependent on the selection of the objects, which evaluations will be then analyzed. In previous ICA applications, we used either predefined sets of objects, e.g. the member states of the European Union, (see e.g. [4–6]), or we used sets of objects which are not individualized, but interchangeable, like the agents in ant colony optimization procedures and other metaheuristics (see e.g. [10]), where what makes the difference is the number of agents, rather than their individual characteristics. Here, in the present leg of ICA research, we discuss the specific case where the belonging of certain objects to certain sets depends specifically on the values of these objects according to the evaluation criteria, which in different subsequent years has produces different objects, but ones within certain predefined limitations, i.e. the set defines the nature of its elements, while in previous steps of the ICA research on GCR the elements defined the nature of the set. This we consider of specific importance regarding the results of the application of ICA on the selected datasets. We choose to run he method for five subsequent years (2013–2014 to 2017–2018), but the interested reader may continue this research with data for the efficiency- to innovation-driven economies from other years as well.

<i>Criteria</i> \ <i>Countries</i>	1	2	3	4	5	6	7	8	9	10	11	12
<i>Argentina</i>	2.8	3.5	4.1	5.8	4.6	3.1	3.1	3.1	3.4	5.0	3.7	3.0
<i>Barbados</i>	4.8	5.5	3.9	6.4	5.3	4.2	4.8	4.7	5.3	2.1	4.3	3.5
<i>Brazil</i>	3.7	4.0	4.6	5.4	4.2	3.8	4.1	4.4	4.1	5.7	4.4	3.4
<i>Chile</i>	4.9	4.5	6.0	5.7	4.9	4.6	4.5	4.8	4.5	4.5	4.2	3.6
<i>Costa Rica</i>	4.2	3.9	4.6	5.8	5.0	4.3	4.5	3.8	4.2	3.4	4.5	3.7
<i>Croatia</i>	3.6	4.7	4.7	5.8	4.5	3.9	3.9	3.9	4.4	3.6	3.8	3.1
<i>Estonia</i>	4.9	4.7	5.9	6.2	5.2	4.7	5.0	4.6	5.2	3.1	4.3	3.9
<i>Hungary</i>	3.7	4.4	4.5	5.9	4.7	4.2	4.2	3.9	4.4	4.3	3.7	3.5
<i>Kazakhstan</i>	4.1	4.2	5.9	5.3	4.5	4.3	5.0	3.7	4.1	4.2	3.7	3.1
<i>Latvia</i>	4.1	4.2	5.6	6.1	4.8	4.5	4.8	4.5	4.7	3.2	4.0	3.2
<i>Lebanon</i>	3.0	2.7	2.5	6.3	4.7	4.4	3.9	3.7	3.5	3.6	4.1	2.7
<i>Lithuania</i>	4.0	4.7	4.9	6.0	5.2	4.4	4.3	3.8	4.8	3.6	4.3	3.6
<i>Malaysia</i>	4.8	5.2	5.4	6.1	4.7	5.2	4.8	5.4	4.2	4.9	5.0	4.4
<i>Mexico</i>	3.6	4.1	5.1	5.7	4.0	4.2	3.9	4.2	3.7	5.6	4.2	3.3
<i>Oman</i>	5.4	5.1	6.6	6.0	4.5	5.0	4.7	4.8	4.1	3.6	4.5	3.6
<i>Panama</i>	4.0	4.9	4.9	5.8	4.3	4.6	4.3	5.0	4.4	3.5	4.3	3.7
<i>Poland</i>	4.0	4.0	4.9	6.0	4.9	4.3	4.2	4.5	4.5	5.1	4.1	3.2
<i>Russian Feder.</i>	3.3	4.6	5.9	5.7	4.7	3.8	4.3	3.4	4.0	5.8	3.6	3.1
<i>Seychelles</i>	4.3	4.6	4.4	5.9	4.1	4.4	4.7	3.9	3.9	1.5	4.1	3.3
<i>Slovak Republic</i>	3.3	4.1	4.9	6.1	4.4	4.2	4.2	4.5	4.2	4.0	4.0	3.0
<i>Turkey</i>	4.1	4.5	4.6	5.9	4.3	4.5	3.7	4.4	4.1	5.3	4.4	3.5
<i>Uruguay</i>	4.6	4.3	4.5	5.9	4.5	4.3	3.4	3.8	4.3	3.3	3.8	3.1

TABLE 2
Efficiency-to-innovation economies in 2013–2014

4 INPUT DATASETS

We take for analysis data for the five most recent years 2013–2018, respectively in Table 2 to Table 5.

We can note that these according to the methodology of GCR, the evaluations presented are numbers on the 1-to-7 scale with 0.1, and the twelve “pillars of competitiveness” are formed on the basis of more than 110 sub-indicators derived from the national statistics.

5 RESULTS AND DISCUSSION

From each input dataset of evaluations (measurements) of objects (in this case, countries) against criteria (i.e., pillars of competitiveness), ICA

<i>Criteria</i> \ <i>Countries</i>	1	2	3	4	5	6	7	8	9	10	11	12
<i>Argentina</i>	2.8	3.5	4.2	5.8	4.8	3.1	3.0	3.0	3.5	5.0	3.7	3.0
<i>Bahrain</i>	4.7	5.2	5.2	6.2	4.7	5.0	4.7	4.7	5.0	3.1	4.3	3.3
<i>Barbados</i>	4.6	5.3	3.4	6.5	5.2	4.3	4.6	4.6	5.0	2.1	4.3	3.6
<i>Brazil</i>	3.5	4.0	4.5	5.7	4.9	3.8	3.8	4.3	4.2	5.7	4.3	3.3
<i>Chile</i>	4.8	4.6	5.9	5.7	5.1	4.7	4.4	4.9	4.6	4.5	4.2	3.5
<i>Costa Rica</i>	4.3	4.1	4.4	6.1	5.0	4.5	4.3	3.7	4.8	3.4	4.5	3.8
<i>Croatia</i>	3.6	4.7	4.4	5.9	4.7	4.1	3.9	3.9	4.6	3.6	3.8	3.1
<i>Hungary</i>	3.7	4.6	4.8	5.8	4.7	4.4	4.2	3.9	4.4	4.3	3.8	3.5
<i>Kazakhstan</i>	4.0	4.2	5.7	5.4	4.5	4.5	4.9	3.7	4.2	4.3	3.8	3.1
<i>Latvia</i>	4.1	4.6	5.5	6.3	5.1	4.7	4.8	4.6	5.1	3.2	4.1	3.3
<i>Lebanon</i>	2.7	2.6	2.6	6.3	4.4	4.3	3.7	3.7	3.5	3.6	3.9	2.8
<i>Lithuania</i>	4.0	4.7	5.3	6.2	5.3	4.6	4.3	4.1	5.4	3.6	4.3	3.6
<i>Malaysia</i>	5.1	5.5	5.3	6.3	4.8	5.4	4.8	5.6	4.2	4.9	5.2	4.7
<i>Mauritius</i>	4.6	4.7	4.7	6.1	4.7	4.9	4.3	4.7	4.0	2.8	4.5	3.2
<i>Mexico</i>	3.4	4.2	5.0	5.7	4.0	4.2	3.7	4.1	3.6	5.6	4.1	3.3
<i>Oman</i>	5.1	5.0	6.6	6.0	4.2	4.8	4.4	4.7	4.2	3.7	4.2	3.3
<i>Panama</i>	3.8	4.8	5.1	5.6	4.4	4.6	4.1	4.8	4.3	3.5	4.2	3.6
<i>Poland</i>	4.0	4.2	4.8	6.2	5.0	4.5	4.1	4.6	4.5	5.1	4.1	3.3
<i>Russian Feder.</i>	3.5	4.8	5.5	6.0	5.0	4.1	4.4	3.5	4.2	5.8	3.8	3.3
<i>Seychelles</i>	4.0	4.5	4.9	6.0	4.0	4.2	4.4	3.6	3.7	1.5	4.0	3.3
<i>Suriname</i>	3.4	3.6	4.8	5.7	3.5	3.7	3.7	3.4	3.7	2.1	3.4	2.6
<i>Turkey</i>	3.9	4.6	4.8	5.8	4.7	4.6	3.5	4.2	4.3	5.3	4.3	3.4
<i>Un. Arab Emir.</i>	5.7	6.3	6.6	6.2	5.9	5.6	5.1	4.9	5.5	4.4	5.3	4.4
<i>Uruguay</i>	4.7	4.5	4.5	5.9	4.7	4.4	3.4	3.8	4.5	3.3	3.8	3.2

TABLE 3
Efficiency-to-innovation economies in 2014–2015

computes a new table that contains intuitionistic fuzzy pairs (IFPs, [2]) giving the measure of dependence between every pair of criteria. In ICA-specific terms, the dependence between two criteria falls in one of the three possible categories: positive consonance, negative consonance or dissonance. Positive consonance in ICA is interpreted as the definite presence of relation between two criteria, with boundary value of $\langle 1; 0 \rangle$, negative consonance is interpreted

<i>Countries</i> Criteria	1	2	3	4	5	6	7	8	9	10	11	12
<i>Argentina</i>	2.9	3.6	4.1	5.8	4.9	3.1	3.1	2.8	3.9	5	3.6	3.1
<i>Brazil</i>	3.2	3.9	4	5.1	3.8	3.7	3.7	4	4.4	5.8	4.1	3.2
<i>Chile</i>	4.6	4.6	5.6	5.6	5	4.6	4.3	4.6	4.8	4.6	4.1	3.5
<i>Costa Rica</i>	4.2	4	4.4	5.9	5	4.3	4.2	3.6	4.6	3.4	4.3	3.7
<i>Croatia</i>	3.6	4.6	4.2	5.8	4.6	4	3.8	3.6	4.6	3.6	3.7	3.1
<i>Hungary</i>	3.5	4.5	4.9	5.7	4.6	4.3	4.2	3.9	4.6	4.3	3.7	3.4
<i>Latvia</i>	4.2	4.5	5.6	6.2	5.1	4.6	4.7	4.4	5.3	3.2	4.1	3.3
<i>Lebanon</i>	3.2	2.7	2.6	6.3	4.5	4.4	3.8	3.8	4	3.6	4.1	3.1
<i>Lithuania</i>	4.1	4.7	5.6	6.2	5.3	4.6	4.3	4	5.6	3.6	4.3	3.7
<i>Malaysia</i>	5.1	5.5	5.4	6.3	5	5.4	4.9	5.2	4.6	5	5.3	4.8
<i>Mauritius</i>	4.5	4.8	4.7	6.1	4.6	4.9	4.3	4.4	4.1	2.8	4.4	3.2
<i>Mexico</i>	3.3	4.2	4.9	5.7	4	4.2	3.8	4.2	3.8	5.7	4.2	3.4
<i>Oman</i>	4.7	4.8	6	5.8	3.9	4.4	4.1	4.2	4.2	3.9	3.9	3
<i>Panama</i>	3.9	4.7	4.8	5.5	4.1	4.6	4.1	4.9	4.4	3.5	4.2	3.6
<i>Poland</i>	4.1	4.3	5.1	6.1	5.1	4.5	4.1	4.3	4.8	5.2	4.1	3.3
<i>Romania</i>	3.7	3.6	5.4	5.5	4.5	4.3	4.1	4	4.6	4.6	3.7	3.2
<i>Russian Feder.</i>	3.5	4.8	5.3	5.9	5	4.2	4.4	3.5	4.2	5.9	3.8	3.3
<i>Seychelles</i>	4	4.5	4.8	5.8	3.8	4.3	4.5	3.4	3.8	1.4	4	3.2
<i>Turkey</i>	3.8	4.4	4.7	5.7	4.6	4.5	3.5	3.9	4.1	5.4	4.1	3.4
<i>Uruguay</i>	4.7	4.4	4.3	5.9	4.7	4.4	3.4	3.9	4.8	3.4	3.8	3.2

TABLE 4
Efficiency-to-innovation economies in 2015–2016

as the definite absence of relation, with boundary value $\langle 0; 1 \rangle$, and dissonance is interpreted as uncertainty, where no particular conclusion can be derived, with boundary value $\langle 0; 0 \rangle$. In the resultant table, along the main diagonal, the IF pairs, which correspond to the dependence of criterion C_i with itself, are all equal to $\langle 1; 0 \rangle$ (every criterion perfectly correlates with itself), and the IF pair corresponding to the pair of criteria C_i, C_j is identical to the one corresponding to the pair C_j, C_i .

The calculations involved in the application of ICA are performed by a special software for ICA [8, 9] that returns for the sake of simplicity the computed result in the form of two tables, one giving the membership parts of the IF pairs, and the other giving the non-membership parts.

<i>Countries</i> Criteria	1	2	3	4	5	6	7	8	9	10	11	12
<i>Argentina</i>	3.0	3.7	2.9	5.9	5.0	3.3	3.3	3.0	4.1	4.9	3.7	3.2
<i>Barbados</i>	4.3	5.1	3.2	6.1	5.2	4.2	4.5	4.1	5.4	1.6	4.2	3.4
<i>Chile</i>	4.5	4.7	5.4	5.7	5.2	4.6	4.4	4.8	5.1	4.5	4.1	3.4
<i>Costa Rica</i>	4.1	4.1	4.4	6.2	5.1	4.2	4.3	4.4	4.8	3.3	4.3	3.6
<i>Croatia</i>	3.6	4.6	4.4	5.8	4.7	4.1	3.9	3.6	4.7	3.5	3.8	3.1
<i>Hungary</i>	3.3	4.2	5.1	5.6	4.4	4.4	4.1	4.0	4.5	4.3	3.5	3.2
<i>Latvia</i>	4.0	4.4	5.6	6.2	5.0	4.5	4.6	4.2	5.2	3.2	4.1	3.4
<i>Lebanon</i>	3.3	2.7	2.3	6.0	4.5	4.4	3.9	4.0	4.0	3.5	4.2	3.4
<i>Lithuania</i>	4.2	4.7	5.4	6.3	5.3	4.6	4.4	4.1	5.6	3.5	4.3	3.7
<i>Malaysia</i>	5.0	5.4	5.4	6.1	5.0	5.2	4.8	5.0	4.8	5.0	5.2	4.7
<i>Mauritius</i>	4.5	4.7	4.9	6.1	4.7	4.9	4.4	4.3	4.2	2.7	4.4	3.3
<i>Mexico</i>	3.3	4.3	5.0	5.7	4.1	4.3	3.8	4.5	4.0	5.6	4.2	3.4
<i>Oman</i>	5.0	4.8	4.5	5.7	4.1	4.5	4.1	4.2	4.4	3.8	3.9	3.3
<i>Panama</i>	4.0	4.9	6.0	5.8	4.1	4.6	4.3	5.1	4.6	3.5	4.3	3.5
<i>Poland</i>	4.0	4.3	5.1	6.2	5.0	4.6	4.1	4.2	4.8	5.1	4.1	3.4
<i>Saudi Arabia</i>	5.1	5.1	4.7	6.0	4.8	4.6	4.3	4.2	5.0	5.4	4.5	3.7
<i>Slovak Republic</i>	3.5	4.2	5.3	6.0	4.5	4.5	4.0	4.6	4.8	4.0	4.1	3.3
<i>Turkey</i>	3.9	4.4	4.9	5.6	4.7	4.5	3.4	3.8	4.2	5.4	4.0	3.3
<i>Uruguay</i>	4.7	4.5	4.3	5.9	4.8	4.4	3.6	4.2	5.2	3.3	3.7	3.2
<i>Croatia</i>	3.0	3.7	2.9	5.9	5.0	3.3	3.3	3.0	4.1	4.9	3.7	3.2

TABLE 5
Efficiency-to-innovation economies in 2016–2017

Below we present the results of the application of ICA on the five input tables in three possible ways: first as two tables per year with the membership and non-membership parts of the intercriteria pairs, second, as points plotted on the IF triangle, and third, intercriteria pairs ranked according to their distance from the “Truth” (the Euclidean distance from the point (1, 0)). In all the tables that follow, the colour legend employed is that the greener the cell, the closer to the “Truth”, and the redder the cell, the closer to the “Falsity”, i.e. point (0, 1).

Figure 2 gives how these 66 intercriteria correlations between the 12 criteria are plotted as points onto the intuitionistic fuzzy triangle for the case of efficiency-to-innovation economies for the year 2013–2014. In what follows

<i>Countries</i> Criteria	1	2	3	4	5	6	7	8	9	10	11	12
<i>Argentina</i>	3.3	3.9	3.4	5.9	5	3.4	3.3	3.1	4.3	4.9	3.8	3.3
<i>Chile</i>	4.5	4.8	5.4	5.8	5.3	4.7	4.4	4.9	5.2	4.5	4.3	3.5
<i>Costa Rica</i>	4.2	4.2	4.5	6.2	5.1	4.4	4.2	4.4	4.9	3.5	4.5	3.7
<i>Croatia</i>	3.5	4.6	4.8	6.1	4.5	4	3.8	3.6	5	3.6	3.8	2.9
<i>Hungary</i>	3.5	4.4	5.1	5.6	4.3	4.4	4.2	4.3	5.1	4.3	3.7	3.4
<i>Latvia</i>	3.8	4.4	5.8	6.1	5	4.4	4.5	4.1	5.3	3.2	4.1	3.2
<i>Lebanon</i>	3.2	2.8	2.5	5.8	4.3	4.4	3.7	3.9	4.4	3.6	4.2	3.4
<i>Lithuania</i>	4.1	4.7	5.6	6.2	5.2	4.6	4.3	4.1	5.6	3.6	4.4	3.7
<i>Malaysia</i>	5	5.5	5.4	6.3	4.9	5.1	4.7	5	4.9	5.1	5.1	4.7
<i>Mauritius</i>	4.5	4.8	4.7	6.1	4.6	4.9	4.4	4.4	4.5	2.8	4.5	3.4
<i>Oman</i>	5	4.9	4.7	5.9	4.4	4.5	3.5	4.2	4.5	4.1	4	3.3
<i>Panama</i>	3.8	4.9	6.1	5.6	4	4.6	4.1	5	4.4	3.6	4.4	3.4
<i>Poland</i>	3.8	4.7	5.2	6.2	5	4.6	4.1	4.2	4.9	5.2	4.1	3.4
<i>Romania</i>	3.7	3.8	5.2	5.5	4.4	4.1	4	3.7	4.8	4.6	3.5	3.1
<i>Saudi Arabia</i>	5	5.2	4.9	6	4.9	4.6	4.1	4.2	4.9	5.4	4.5	3.7
<i>Seychelles</i>	3.8	4.6	4.6	6	3.9	4.3	4.1	3.3	4.2	1.4	3.9	2.9
<i>Slovak Republic</i>	3.5	4.3	5.4	6.1	4.5	4.5	4	4.6	5.1	4.1	4.2	3.3
<i>Trinidad&Tobago</i>	3.5	4.3	3.8	5.9	5.1	4.1	4	4.2	4.9	3.2	4.1	3
<i>Turkey</i>	3.8	4.5	5.1	5.6	4.8	4.5	3.4	3.8	4.4	5.5	4	3.3
<i>Uruguay</i>	4.6	4.7	4.3	5.8	4.6	4.3	3.5	4.1	5.3	3.3	3.8	3.1

TABLE 6
Efficiency-to-innovation economies in 2017–2018

the results of the application of ICA to the datasets for years 2014–2015, 2015–2016 and 2016–2017 are given in tabular form in Tables 8 to 11, and in graphical form in Figures 3 to 6, respectively.

In addition, for each of the intercriteria points in each year, we have calculated its Euclidean distance from the point “Truth” (1, 0), where we are mostly interested in the points most closely located in proximity to this point. Rankings of these points was made according to these Euclidean distances, and we present below the Top 10 and Bottom 10 pairs for each year (Tables 12 to 16) in support of the discussion of the results that follows. The parameter d is calculated by the formula

$$d = \sqrt{(1 - \mu)^2 + \nu^2}.$$

(a) Memberships

μ	1	2	3	4	5	6	7	8	9	10	11	12
1	1.000	0.662	0.580	0.524	0.545	0.697	0.701	0.654	0.623	0.294	0.632	0.693
2	0.662	1.000	0.580	0.528	0.511	0.619	0.628	0.645	0.615	0.381	0.554	0.654
3	0.580	0.580	1.000	0.385	0.468	0.580	0.649	0.610	0.528	0.528	0.485	0.550
4	0.524	0.528	0.385	1.000	0.580	0.550	0.519	0.567	0.580	0.264	0.519	0.476
5	0.545	0.511	0.468	0.580	1.000	0.494	0.576	0.463	0.697	0.359	0.472	0.550
6	0.697	0.619	0.580	0.550	0.494	1.000	0.615	0.658	0.532	0.333	0.645	0.667
7	0.701	0.628	0.649	0.519	0.576	0.615	1.000	0.597	0.593	0.316	0.532	0.610
8	0.654	0.645	0.610	0.567	0.463	0.658	0.597	1.000	0.641	0.403	0.675	0.684
9	0.623	0.615	0.528	0.580	0.697	0.532	0.593	0.641	1.000	0.294	0.506	0.602
10	0.294	0.381	0.528	0.264	0.359	0.333	0.316	0.403	0.294	1.000	0.407	0.394
11	0.632	0.554	0.485	0.519	0.472	0.645	0.532	0.675	0.506	0.407	1.000	0.719
12	0.693	0.654	0.550	0.476	0.550	0.667	0.610	0.684	0.602	0.394	0.719	1.000

(b) Non-memberships

ν	1	2	3	4	5	6	7	8	9	10	11	12
1	0.000	0.264	0.342	0.346	0.342	0.186	0.212	0.247	0.281	0.632	0.255	0.190
2	0.264	0.000	0.329	0.346	0.398	0.277	0.273	0.268	0.294	0.567	0.346	0.242
3	0.342	0.329	0.000	0.485	0.411	0.286	0.255	0.299	0.368	0.390	0.403	0.333
4	0.346	0.346	0.485	0.000	0.264	0.281	0.333	0.307	0.290	0.628	0.333	0.390
5	0.342	0.398	0.411	0.264	0.000	0.372	0.294	0.420	0.199	0.558	0.407	0.342
6	0.186	0.277	0.286	0.281	0.372	0.000	0.251	0.221	0.333	0.571	0.212	0.203
7	0.212	0.273	0.255	0.333	0.294	0.251	0.000	0.294	0.286	0.602	0.338	0.255
8	0.247	0.268	0.299	0.307	0.420	0.221	0.294	0.000	0.268	0.519	0.216	0.212
9	0.281	0.294	0.368	0.290	0.199	0.333	0.286	0.268	0.000	0.623	0.372	0.273
10	0.632	0.567	0.390	0.628	0.558	0.571	0.602	0.519	0.623	0.000	0.494	0.519
11	0.255	0.346	0.403	0.333	0.407	0.212	0.338	0.216	0.372	0.494	0.000	0.147
12	0.190	0.242	0.333	0.390	0.342	0.203	0.255	0.212	0.273	0.519	0.147	0.000

TABLE 7

Intercriteria dependencies between the pillars of competitiveness of the global efficiency-innovation economies in year 2013–2014 (Input: Table 2)

With this way of presenting the results we aim at outlines the best correlating pairs (i.e., those with the highest *positive consonance*), and the worst correlating ones (i.e. those with the highest *negative consonance*). In between are the rest of the pairs, which exhibit the so termed *dissonance*, featuring higher levels of uncertainty, i.e. the points plotted in the middle of the triangle.

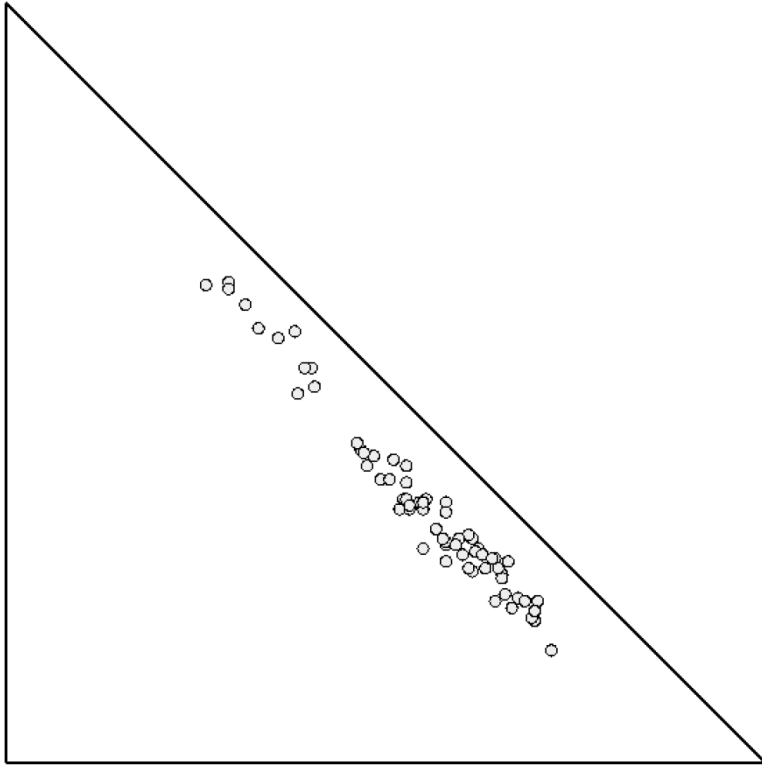


FIGURE 2

IFS triangle with intercriteria relations for the global efficiency-to-innovation economies in year 2013–2014 (see Table 7)

Before proceeding to the discussion, we complete the presentation of the results by giving the total comparison per year of all the 66 intercriteria pairs and their distances to the “truth” point (Table 17). It is noteworthy that such kind of timewise presentation of ICA results has not been done so far, and it is specifically indicative to outline specific trends over the years.

The results of the application of ICA to data for the transition economies from efficiency- to innovation-driven for the last five years show patterns, which we have detected in previous runs of the method over other sets of countries, for instance the member states of the European Union. One of the observations that we have detected in the past is the low correlation which one of the indicators, “10 Market size”, has with practically most of the rest of the criteria. We note that market size is specifically unrelated to indicators like “9 Technological readiness”, “4 Health and primary education” and “1 Institutions”, especially in the first years of the studied period. There is

(a) Memberships

μ	1	2	3	4	5	6	7	8	9	10	11	12
1	1.000	0.699	0.638	0.583	0.572	0.779	0.717	0.721	0.670	0.388	0.656	0.616
2	0.699	1.000	0.641	0.576	0.572	0.714	0.696	0.699	0.634	0.431	0.623	0.641
3	0.638	0.641	1.000	0.413	0.486	0.670	0.696	0.616	0.522	0.533	0.504	0.547
4	0.583	0.576	0.413	1.000	0.587	0.572	0.601	0.518	0.569	0.348	0.576	0.518
5	0.572	0.572	0.486	0.587	1.000	0.569	0.565	0.565	0.699	0.522	0.580	0.605
6	0.779	0.714	0.670	0.572	0.569	1.000	0.681	0.775	0.620	0.438	0.710	0.609
7	0.717	0.696	0.696	0.601	0.565	0.681	1.000	0.620	0.623	0.417	0.591	0.587
8	0.721	0.699	0.616	0.518	0.565	0.775	0.620	1.000	0.601	0.496	0.707	0.634
9	0.670	0.634	0.522	0.569	0.699	0.620	0.623	0.601	1.000	0.395	0.580	0.630
10	0.388	0.431	0.533	0.348	0.522	0.438	0.417	0.496	0.395	1.000	0.438	0.464
11	0.656	0.623	0.504	0.576	0.580	0.710	0.591	0.707	0.580	0.438	1.000	0.696
12	0.616	0.641	0.547	0.518	0.605	0.609	0.587	0.634	0.630	0.464	0.696	1.000

(b) Non-memberships

ν	1	2	3	4	5	6	7	8	9	10	11	12
1	0.000	0.217	0.283	0.308	0.315	0.149	0.199	0.196	0.246	0.554	0.207	0.236
2	0.217	0.000	0.275	0.297	0.319	0.210	0.210	0.207	0.257	0.507	0.236	0.199
3	0.283	0.275	0.000	0.471	0.402	0.250	0.214	0.301	0.380	0.409	0.359	0.297
4	0.308	0.297	0.471	0.000	0.264	0.304	0.308	0.355	0.297	0.551	0.264	0.312
5	0.315	0.319	0.402	0.264	0.000	0.341	0.304	0.326	0.163	0.380	0.272	0.214
6	0.149	0.210	0.250	0.304	0.341	0.000	0.228	0.149	0.290	0.504	0.174	0.243
7	0.199	0.210	0.214	0.308	0.304	0.228	0.000	0.286	0.275	0.514	0.275	0.261
8	0.196	0.207	0.301	0.355	0.326	0.149	0.286	0.000	0.297	0.442	0.167	0.214
9	0.246	0.257	0.380	0.297	0.163	0.290	0.275	0.297	0.000	0.529	0.279	0.210
10	0.554	0.507	0.409	0.551	0.380	0.504	0.514	0.442	0.529	0.000	0.453	0.395
11	0.207	0.236	0.359	0.264	0.272	0.174	0.275	0.167	0.279	0.453	0.000	0.127
12	0.236	0.199	0.297	0.312	0.214	0.243	0.261	0.214	0.210	0.395	0.127	0.000

TABLE 8

Intercriteria dependencies between the pillars of competitiveness of the global efficiency-to-innovation economies in year 2014–2015 (Input: Table 3)

however an obvious trend over the years, that for this particular set of countries, efficiency-to-innovation driven, this indicator slowly returns its importance, as its intercriteria correlation with practically all other criteria starts increasing in the end of the period.

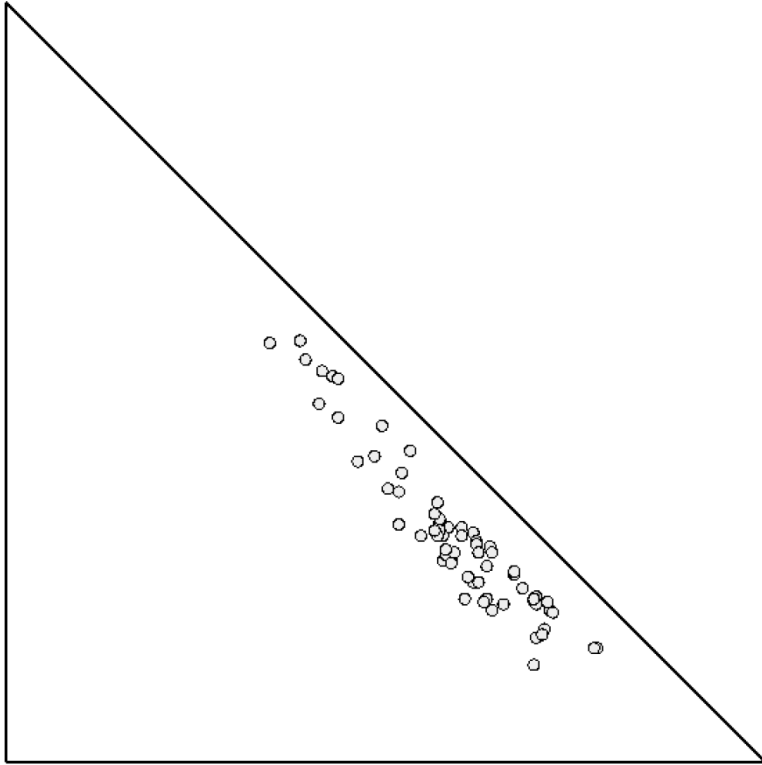


FIGURE 3

IFS triangle with intercriteria relations for the global efficiency-to-innovation economies in year 2014–2015 (see Table 8)

As we have noted in previous legs of research, indicator “7 Labor market efficiency” is a criterion that used to be low correlated in the past but exhibits a stably growing correlation with some of the rest criteria, especially with the two indicators from the innovation-driven group: “11 Business sophistication” and “12 Innovation”.

Among all 66 intercriteria pairs, there are several pairs worth mentioning that are regularly appearing in the Top 10 intercriteria correlations across the years. Pairs “1 Institutions – 6 Goods market efficiency” and “11 Business sophistication – 12 Innovation” appear in all 5 years. Pairs “6 Goods market efficiency – 8 Financial market development”, “8 Financial market development – 11 Business sophistication”, “6 Goods market efficiency – 11 Business sophistication”, “5 Higher education and training – 9 Technological readiness” appear in four of the five years. Pairs “1 Institutions – 2 Infrastructure” and “6 Goods market efficiency – 12 Innovation” appear in three

(a) Memberships

μ	1	2	3	4	5	6	7	8	9	10	11	12
1	1.000	0.674	0.653	0.568	0.547	0.726	0.637	0.658	0.605	0.321	0.589	0.547
2	0.674	1.000	0.653	0.511	0.500	0.642	0.653	0.611	0.495	0.405	0.516	0.532
3	0.653	0.653	1.000	0.489	0.563	0.621	0.674	0.637	0.605	0.463	0.479	0.568
4	0.568	0.511	0.489	1.000	0.642	0.568	0.568	0.447	0.489	0.337	0.526	0.447
5	0.547	0.500	0.563	0.642	1.000	0.547	0.537	0.468	0.695	0.447	0.479	0.584
6	0.726	0.642	0.621	0.568	0.547	1.000	0.626	0.716	0.579	0.316	0.679	0.579
7	0.637	0.653	0.674	0.568	0.537	0.626	1.000	0.563	0.532	0.358	0.558	0.574
8	0.658	0.611	0.637	0.447	0.468	0.716	0.563	1.000	0.568	0.468	0.632	0.595
9	0.605	0.495	0.605	0.489	0.695	0.579	0.532	0.568	1.000	0.384	0.463	0.532
10	0.321	0.405	0.463	0.337	0.447	0.316	0.358	0.468	0.384	1.000	0.368	0.463
11	0.589	0.516	0.479	0.526	0.479	0.679	0.558	0.632	0.463	0.368	1.000	0.647
12	0.547	0.532	0.568	0.447	0.584	0.579	0.574	0.595	0.532	0.463	0.647	1.000

(b) Non-memberships

ν	1	2	3	4	5	6	7	8	9	10	11	12
1	0.000	0.247	0.284	0.321	0.347	0.168	0.268	0.268	0.279	0.621	0.284	0.321
2	0.247	0.000	0.258	0.353	0.368	0.237	0.226	0.300	0.374	0.511	0.321	0.311
3	0.284	0.258	0.000	0.411	0.332	0.284	0.232	0.279	0.289	0.468	0.384	0.300
4	0.321	0.353	0.411	0.000	0.216	0.268	0.289	0.432	0.337	0.558	0.289	0.405
5	0.347	0.368	0.332	0.216	0.000	0.284	0.316	0.416	0.168	0.442	0.353	0.263
6	0.168	0.237	0.284	0.268	0.284	0.000	0.237	0.147	0.274	0.563	0.153	0.237
7	0.268	0.226	0.232	0.289	0.316	0.237	0.000	0.321	0.321	0.553	0.263	0.263
8	0.268	0.300	0.279	0.432	0.416	0.147	0.321	0.000	0.305	0.453	0.211	0.274
9	0.279	0.374	0.289	0.337	0.168	0.274	0.321	0.305	0.000	0.495	0.379	0.274
10	0.621	0.511	0.468	0.558	0.442	0.563	0.553	0.453	0.495	0.000	0.489	0.411
11	0.284	0.321	0.384	0.289	0.353	0.153	0.263	0.211	0.379	0.489	0.000	0.158
12	0.321	0.311	0.300	0.405	0.263	0.237	0.263	0.274	0.274	0.411	0.158	0.000

TABLE 9

Intercriteria dependencies between the pillars of competitiveness of the global efficiency-to-innovation economies in year 2015–2016 (Input: Table 4)

of the years in the period. Pairs “1 Institutions – 7 Labor market efficiency”, “2 Infrastructure – 6 Goods market efficiency”, “4 Health and primary education – 5 Higher education and training”, “6 Goods market efficiency – 7 Labor market efficiency”, “8 Financial market development – 12 Innovation”

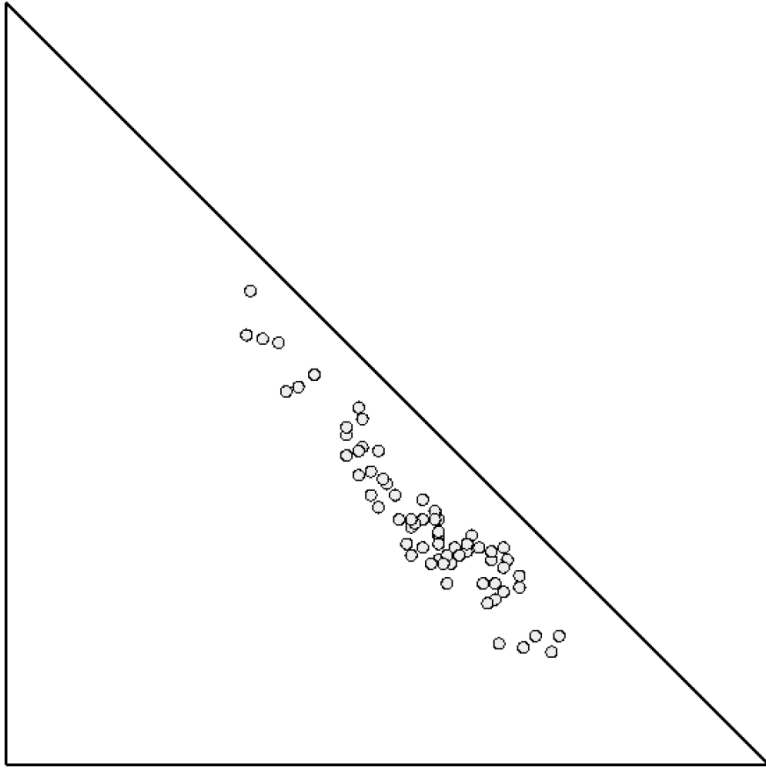


FIGURE 4

IFS triangle with intercriteria relations for the global efficiency-to-innovation economies in year 2015–2016 (see Table 9)

appear in two of the five years. We can note that criteria 6–8–11 are even forming an intercriteria triple (see [7, 10, 17]).

Some of these pairs, like 1–12, 5–9, 8–11, 8–12 were expected to appear on the basis of other legs of ICA research on the data from the Global Competitiveness Reports. Some like pairs 4–5 and 6–7 are however novel and appearing just in the so researched set of countries.

6 CONCLUSION

Several findings were outlined from the results of application of InterCriteria Analysis (ICA) on datasets extracted from the World Economic Forum's Global Competitiveness Reports for the countries in the transition stage between efficiency- and innovation-driven in the period 2013–2018. The set

(a) Memberships

μ	1	2	3	4	5	6	7	8	9	10	11	12
1	1.000	0.760	0.503	0.515	0.567	0.649	0.667	0.602	0.649	0.386	0.620	0.567
2	0.760	1.000	0.573	0.462	0.485	0.637	0.684	0.556	0.608	0.433	0.596	0.550
3	0.503	0.573	1.000	0.462	0.444	0.673	0.655	0.678	0.567	0.509	0.550	0.561
4	0.515	0.462	0.462	1.000	0.667	0.474	0.614	0.468	0.620	0.298	0.608	0.596
5	0.567	0.485	0.444	0.667	1.000	0.427	0.561	0.404	0.702	0.345	0.497	0.520
6	0.649	0.637	0.673	0.474	0.427	1.000	0.637	0.637	0.485	0.474	0.632	0.602
7	0.667	0.684	0.655	0.614	0.561	0.637	1.000	0.614	0.655	0.333	0.655	0.620
8	0.602	0.556	0.678	0.468	0.404	0.637	0.614	1.000	0.480	0.450	0.620	0.579
9	0.649	0.608	0.567	0.620	0.702	0.485	0.655	0.480	1.000	0.327	0.509	0.526
10	0.386	0.433	0.509	0.298	0.345	0.474	0.333	0.450	0.327	1.000	0.421	0.433
11	0.620	0.596	0.550	0.608	0.497	0.632	0.655	0.620	0.509	0.421	1.000	0.789
12	0.567	0.550	0.561	0.596	0.520	0.602	0.620	0.579	0.526	0.433	0.789	1.000

(b) Non-memberships

ν	1	2	3	4	5	6	7	8	9	10	11	12
1	0.000	0.164	0.415	0.363	0.310	0.211	0.240	0.304	0.263	0.520	0.281	0.263
2	0.164	0.000	0.363	0.409	0.386	0.228	0.251	0.333	0.298	0.480	0.287	0.275
3	0.415	0.363	0.000	0.415	0.444	0.187	0.275	0.216	0.357	0.409	0.339	0.269
4	0.363	0.409	0.415	0.000	0.193	0.322	0.240	0.386	0.251	0.579	0.251	0.205
5	0.310	0.386	0.444	0.193	0.000	0.368	0.292	0.462	0.181	0.520	0.351	0.281
6	0.211	0.228	0.187	0.322	0.368	0.000	0.211	0.211	0.345	0.374	0.211	0.205
7	0.240	0.251	0.275	0.240	0.292	0.211	0.000	0.269	0.234	0.573	0.222	0.175
8	0.304	0.333	0.216	0.386	0.462	0.211	0.269	0.000	0.409	0.433	0.246	0.216
9	0.263	0.298	0.357	0.251	0.181	0.345	0.234	0.409	0.000	0.573	0.386	0.298
10	0.520	0.480	0.409	0.579	0.520	0.374	0.573	0.433	0.573	0.000	0.468	0.374
11	0.281	0.287	0.339	0.251	0.351	0.211	0.222	0.246	0.386	0.468	0.000	0.070
12	0.263	0.275	0.269	0.205	0.281	0.205	0.175	0.216	0.298	0.374	0.070	0.000

TABLE 10

Intercriteria dependencies between the pillars of competitiveness of the global efficiency-to-innovation economies in year 2016–2017 (Input: Table 5)

of countries being analysed itself is interesting in that it contains some constant members, true representatives of this economic transition, but also there are countries which sporadically enter this group, or enter or leave it over the years. Thus, this is arguably the first time when ICA is applied on a set

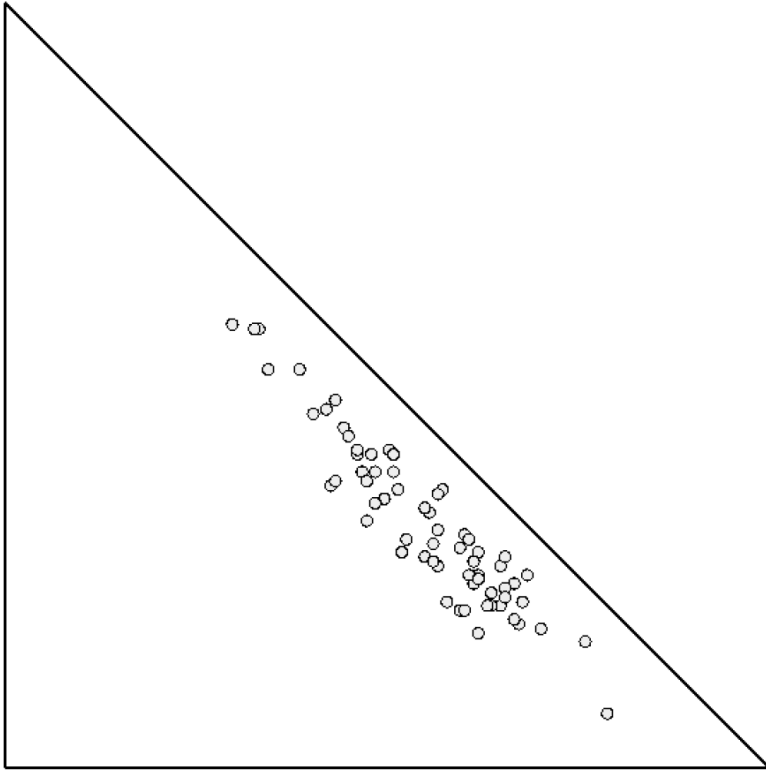


FIGURE 5

IFS triangle with intercriteria relations for the global efficiency-to-innovation economies in year 2016–2017 (see Table 10)

of elements, which belongingness to the set depends on their performance according to the criteria within some predefined limits, which is a different postulation from analysing a fixed set of elements, which belong to the analysed set regardless of their performance, like in the case of EU member states from previous legs of research, analysing data from the same sources.

This observation is noteworthy in the light of the comparability of the results over the years, as well as with results of ICA application over the sets of efficiency-driven, and of innovation-driven countries, taken alone. These comparisons can shed further light on the inherent relations between the twelve pillars of competitiveness, across different selections of analysed countries, across over large periods of time, as well as be indicative of various trends that take place in the global economies, and not only confirm some known or predictable patterns but also help detecting new ones, using the apparatus of the intuitionistic fuzzy sets-based InterCriteria Analysis.

(a) Memberships

μ	1	2	3	4	5	6	7	8	9	10	11	12
1	1.000	0.753	0.511	0.516	0.526	0.642	0.621	0.579	0.489	0.447	0.600	0.553
2	0.753	1.000	0.605	0.521	0.479	0.705	0.600	0.626	0.484	0.505	0.611	0.563
3	0.511	0.605	1.000	0.489	0.505	0.632	0.647	0.616	0.611	0.532	0.542	0.526
4	0.516	0.521	0.489	1.000	0.584	0.521	0.595	0.505	0.516	0.374	0.611	0.526
5	0.526	0.479	0.505	0.584	1.000	0.511	0.532	0.500	0.621	0.500	0.579	0.537
6	0.642	0.705	0.632	0.521	0.511	1.000	0.689	0.705	0.468	0.537	0.726	0.726
7	0.621	0.600	0.647	0.595	0.532	0.689	1.000	0.653	0.584	0.384	0.642	0.600
8	0.579	0.626	0.616	0.505	0.500	0.705	0.653	1.000	0.547	0.468	0.700	0.637
9	0.489	0.484	0.611	0.516	0.621	0.468	0.584	0.547	1.000	0.421	0.479	0.474
10	0.447	0.505	0.532	0.374	0.500	0.537	0.384	0.468	0.421	1.000	0.442	0.568
11	0.600	0.611	0.542	0.611	0.579	0.726	0.642	0.700	0.479	0.442	1.000	0.716
12	0.553	0.563	0.526	0.526	0.537	0.726	0.600	0.637	0.474	0.568	0.716	1.000

(b) Non-memberships

ν	1	2	3	4	5	6	7	8	9	10	11	12
1	0.000	0.121	0.353	0.300	0.353	0.174	0.263	0.268	0.353	0.405	0.242	0.242
2	0.121	0.000	0.321	0.347	0.432	0.184	0.316	0.284	0.389	0.411	0.284	0.295
3	0.353	0.321	0.000	0.389	0.416	0.247	0.258	0.295	0.284	0.395	0.363	0.332
4	0.300	0.347	0.389	0.000	0.279	0.300	0.253	0.347	0.321	0.484	0.226	0.295
5	0.353	0.432	0.416	0.279	0.000	0.363	0.358	0.395	0.268	0.411	0.321	0.316
6	0.174	0.184	0.247	0.300	0.363	0.000	0.211	0.158	0.368	0.353	0.142	0.137
7	0.263	0.316	0.258	0.253	0.358	0.211	0.000	0.237	0.279	0.511	0.232	0.237
8	0.268	0.284	0.295	0.347	0.395	0.158	0.237	0.000	0.353	0.432	0.200	0.195
9	0.353	0.389	0.284	0.321	0.268	0.368	0.279	0.353	0.000	0.463	0.395	0.353
10	0.405	0.411	0.395	0.484	0.411	0.353	0.511	0.432	0.463	0.000	0.474	0.300
11	0.242	0.284	0.363	0.226	0.321	0.142	0.232	0.200	0.395	0.474	0.000	0.132
12	0.242	0.295	0.332	0.295	0.316	0.137	0.237	0.195	0.353	0.300	0.132	0.000

TABLE 11

Intercriteria dependencies between the pillars of competitiveness of the global efficiency-innovation economies in year 2017–2018 (Input: Table 6)

The detected intercriteria relations can be inspiring for economists to extend this research with additional observations on the rest of the pillars, The present research however address the observation in the 2015–2016 GCR

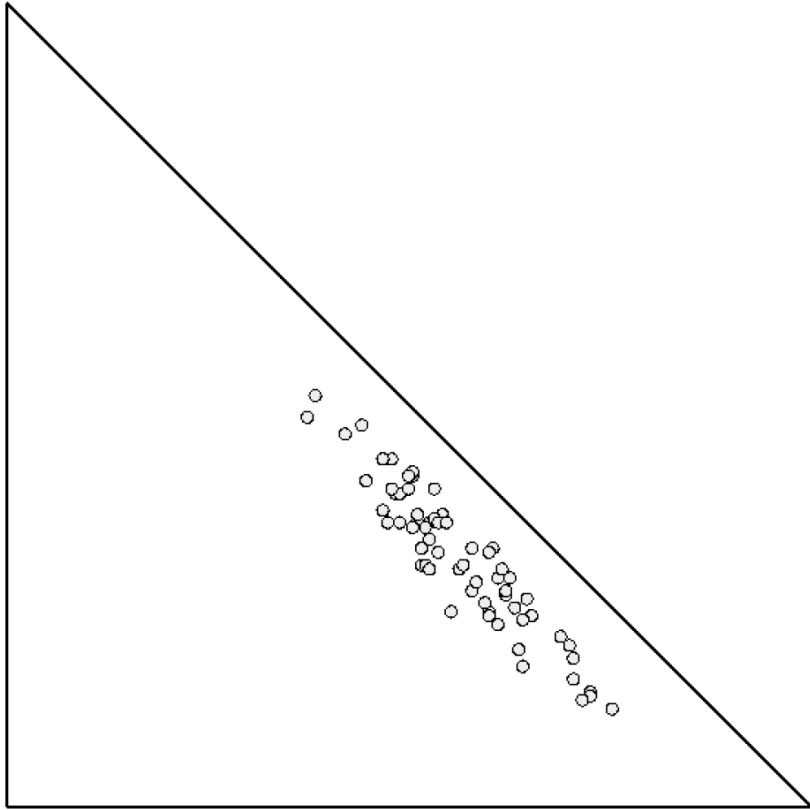


FIGURE 6
IFS triangle with intercriteria relations for the global efficiency-to-innovation economies in year 2017–2018 (see Table 11)

that the pillars of competitiveness are not independent, and they tend to reinforce each other. The attempt to identify the correlations between the different pillars of competitiveness further resonates with the WEF's address to state policy makers to identify and strengthen the transformative forces that will drive future economic growth [12].

ACKNOWLEDGEMENTS

The present research is funded by the National Science Fund of Bulgaria, Grant No. DFNI-I-02-5/2014 “InterCriteria Analysis: A New Approach to Decision Making”.

C_i	C_j	μ	ν	d to Truth
11 Business sophistication	12 Innovation	0.719	0.147	0.318
1 Institutions	6 Goods market efficiency	0.697	0.186	0.356
1 Institutions	12 Innovation	0.693	0.190	0.362
5 Higher education and training	9 Technological readiness	0.697	0.199	0.363
1 Institutions	7 Labor market efficiency	0.701	0.212	0.366
8 Financial market development	12 Innovation	0.684	0.212	0.381
8 Financial market development	11 Business sophistication	0.675	0.216	0.390
6 Goods market efficiency	12 Innovation	0.667	0.203	0.391
6 Goods market efficiency	8 Financial market development	0.658	0.221	0.407
6 Goods market efficiency	11 Business sophistication	0.645	0.212	0.414
...				
3 Macroeconomic environment	4 Health and primary education	0.385	0.485	0.783
8 Financial market development	10 Market size	0.403	0.519	0.792
10 Market size	12 Innovation	0.394	0.519	0.798
2 Infrastructure	10 Market size	0.381	0.567	0.840
5 Higher education and training	10 Market size	0.359	0.558	0.850
6 Goods market efficiency	10 Market size	0.333	0.571	0.878
7 Labor market efficiency	10 Market size	0.316	0.602	0.911
9 Technological readiness	10 Market size	0.294	0.623	0.942
1 Institutions	10 Market size	0.294	0.632	0.947
4 Health and primary education	10 Market size	0.264	0.628	0.967

TABLE 12
 Top 10 and Bottom 10 intercriteria pairs for year 2013–2014 (see Table 7)

C_i	C_j	μ	ν	d to Truth
1 Institutions	6 Goods market efficiency	0.779	0.149	0.266
6 Goods market efficiency	8 Financial market development	0.775	0.149	0.269
11 Business sophistication	12 Innovation	0.696	0.127	0.330
8 Financial market development	11 Business sophistication	0.707	0.167	0.338
6 Goods market efficiency	11 Business sophistication	0.710	0.174	0.338
1 Institutions	8 Financial market development	0.721	0.196	0.341
5 Higher education and training	9 Technological readiness	0.699	0.163	0.342
1 Institutions	7 Labor market efficiency	0.717	0.199	0.346
2 Infrastructure	6 Goods market efficiency	0.714	0.210	0.355
2 Infrastructure	8 Financial market development	0.699	0.207	0.365
...				
10 Market size	12 Innovation	0.464	0.395	0.666
8 Financial market development	10 Market size	0.496	0.442	0.670
10 Market size	11 Business sophistication	0.438	0.453	0.721
3 Macroeconomic environment	4 Health and primary education	0.413	0.471	0.753
6 Goods market efficiency	10 Market size	0.438	0.504	0.754
2 Infrastructure	10 Market size	0.431	0.507	0.762
7 Labor market efficiency	10 Market size	0.417	0.514	0.778
9 Technological readiness	10 Market size	0.395	0.529	0.804
1 Institutions	10 Market size	0.388	0.554	0.826
4 Health and primary education	10 Market size	0.348	0.551	0.854

TABLE 13
 Top 10 and Bottom 10 intercriteria pairs for year 2014–2015 (see Table 8)

C_i	C_j	μ	ν	d to Truth
6 Goods market efficiency	8 Financial market development	0.716	0.147	0.320
1 Institutions	6 Goods market efficiency	0.726	0.168	0.321
5 Higher education and training	9 Technological readiness	0.695	0.168	0.349
6 Goods market efficiency	11 Business sophistication	0.679	0.153	0.355
11 Business sophistication	12 Innovation	0.647	0.158	0.386
3 Macroeconomic environment	7 Labor market efficiency	0.674	0.232	0.400
1 Institutions	2 Infrastructure	0.674	0.247	0.409
2 Infrastructure	7 Labor market efficiency	0.653	0.226	0.415
4 Health and primary education	5 Higher education and training	0.642	0.216	0.418
8 Financial market development	11 Business sophistication	0.632	0.211	0.424
...				
4 Health and primary education	8 Financial market development	0.447	0.432	0.701
5 Higher education and training	10 Market size	0.447	0.442	0.708
3 Macroeconomic environment	10 Market size	0.463	0.468	0.712
2 Infrastructure	10 Market size	0.405	0.511	0.784
9 Technological readiness	10 Market size	0.384	0.495	0.790
10 Market size	11 Business sophistication	0.368	0.489	0.799
7 Labor market efficiency	10 Market size	0.358	0.553	0.847
4 Health and primary education	10 Market size	0.337	0.558	0.867
6 Goods market efficiency	10 Market size	0.316	0.563	0.886
1 Institutions	10 Market size	0.321	0.621	0.920

TABLE 14

Top 10 and Bottom 10 intercriteria pairs for year 2015–2016 (see Table 9)

C_i	C_j	μ	ν	d to Truth
11 Business sophistication	12 Innovation	0.789	0.070	0.222
1 Institutions	2 Infrastructure	0.760	0.164	0.290
7 Labor market efficiency	12 Innovation	0.620	0.175	0.419
5 Higher education and training	9 Technological readiness	0.702	0.181	0.349
3 Macroeconomic environment	6 Goods market efficiency	0.673	0.187	0.377
4 Health and primary education	5 Higher education and training	0.667	0.193	0.385
4 Health and primary education	12 Innovation	0.596	0.205	0.452
6 Goods market efficiency	12 Innovation	0.602	0.205	0.447
1 Institutions	6 Goods market efficiency	0.649	0.211	0.409
6 Goods market efficiency	7 Labor market efficiency	0.637	0.211	0.419
...				
8 Financial market development	10 Market size	0.450	0.433	0.700
3 Macroeconomic environment	5 Higher education and training	0.444	0.444	0.711
5 Higher education and training	8 Financial market development	0.404	0.462	0.754
10 Market size	11 Business sophistication	0.421	0.468	0.744
2 Infrastructure	10 Market size	0.433	0.480	0.743
1 Institutions	10 Market size	0.386	0.520	0.805
5 Higher education and training	10 Market size	0.345	0.520	0.837
7 Labor market efficiency	10 Market size	0.333	0.573	0.879
9 Technological readiness	10 Market size	0.327	0.573	0.884
4 Health and primary education	10 Market size	0.298	0.579	0.910

TABLE 15

Top 10 and Bottom 10 intercriteria pairs for year 2016–2017 (see Table 10)

C_i	C_j	μ	ν	d to Truth
1 Institutions	2 Infrastructure	0.753	0.121	0.275
6 Goods market efficiency	12 Innovation	0.726	0.137	0.306
6 Goods market efficiency	11 Business sophistication	0.726	0.142	0.308
11 Business sophistication	12 Innovation	0.716	0.132	0.313
6 Goods market efficiency	8 Financial market development	0.705	0.158	0.334
2 Infrastructure	6 Goods market efficiency	0.705	0.184	0.348
8 Financial market development	11 Business sophistication	0.700	0.200	0.361
6 Goods market efficiency	7 Labor market efficiency	0.689	0.211	0.375
1 Institutions	6 Goods market efficiency	0.642	0.174	0.398
8 Financial market development	12 Innovation	0.637	0.195	0.412
...				
6 Goods market efficiency	9 Technological readiness	0.468	0.368	0.647
5 Higher education and training	10 Market size	0.500	0.411	0.647
9 Technological readiness	11 Business sophistication	0.479	0.395	0.654
2 Infrastructure	5 Higher education and training	0.479	0.432	0.677
8 Financial market development	10 Market size	0.468	0.432	0.685
1 Institutions	10 Market size	0.447	0.405	0.685
10 Market size	11 Business sophistication	0.442	0.474	0.732
9 Technological readiness	10 Market size	0.421	0.463	0.741
4 Health and primary education	10 Market size	0.374	0.484	0.792
7 Labor market efficiency	10 Market size	0.384	0.511	0.800

TABLE 16
Top 10 and Bottom 10 intercriteria pairs for year 2017–2018 (see Table 11)

C_i	C_j	2013–2014	2014–2015	2015–2016	2016–2017	2017–2018
1 Institutions	2 Infrastructure	0.429	0.371	0.409	0.290	0.275
1 Institutions	3 Macroeconomic environment	0.542	0.460	0.449	0.648	0.603
1 Institutions	4 Health and primary education	0.589	0.518	0.538	0.606	0.570
1 Institutions	5 Higher education and training	0.569	0.531	0.571	0.532	0.591
1 Institutions	6 Goods market efficiency	0.356	0.266	0.321	0.409	0.398
1 Institutions	7 Labor market efficiency	0.366	0.346	0.452	0.411	0.461
1 Institutions	8 Financial market development	0.425	0.341	0.435	0.501	0.499
1 Institutions	9 Technological readiness	0.470	0.412	0.483	0.439	0.620
1 Institutions	10 Market size	0.947	0.826	0.920	0.805	0.685
1 Institutions	11 Business sophistication	0.448	0.401	0.499	0.473	0.468
1 Institutions	12 Innovation	0.362	0.451	0.555	0.506	0.509
2 Infrastructure	3 Macroeconomic environment	0.533	0.452	0.433	0.560	0.509
2 Infrastructure	4 Health and primary education	0.585	0.518	0.603	0.676	0.592

TABLE 17
(Continued)

2 Infrastructure	5 Higher education and training	0.631	0.533	0.621	0.643	0.677
2 Infrastructure	6 Goods market efficiency	0.471	0.355	0.429	0.428	0.348
2 Infrastructure	7 Labor market efficiency	0.462	0.370	0.415	0.404	0.510
2 Infrastructure	8 Financial market development	0.445	0.365	0.492	0.556	0.469
2 Infrastructure	9 Technological readiness	0.485	0.447	0.628	0.492	0.646
2 Infrastructure	10 Market size	0.840	0.762	0.784	0.743	0.643
2 Infrastructure	11 Business sophistication	0.565	0.444	0.581	0.495	0.482
2 Infrastructure	12 Innovation	0.423	0.410	0.562	0.528	0.527
3 Macroeconomic environment	4 Health and primary education	0.783	0.753	0.655	0.680	0.642
3 Macroeconomic environment	5 Higher education and training	0.673	0.653	0.548	0.711	0.646
3 Macroeconomic environment	6 Goods market efficiency	0.508	0.414	0.474	0.377	0.444
3 Macroeconomic environment	7 Labor market efficiency	0.434	0.372	0.400	0.441	0.437
3 Macroeconomic environment	8 Financial market development	0.491	0.488	0.458	0.388	0.484
3 Macroeconomic environment	9 Technological readiness	0.598	0.611	0.490	0.561	0.482
3 Macroeconomic environment	10 Market size	0.612	0.621	0.712	0.639	0.613
3 Macroeconomic environment	11 Business sophistication	0.654	0.612	0.647	0.564	0.584
3 Macroeconomic environment	12 Innovation	0.560	0.542	0.526	0.515	0.578
4 Health and primary education	5 Higher education and training	0.496	0.490	0.418	0.385	0.501
4 Health and primary education	6 Goods market efficiency	0.531	0.525	0.508	0.617	0.565
4 Health and primary education	7 Labor market efficiency	0.585	0.504	0.520	0.454	0.478
4 Health and primary education	8 Financial market development	0.531	0.599	0.701	0.657	0.605
4 Health and primary education	9 Technological readiness	0.510	0.524	0.612	0.456	0.581
4 Health and primary education	10 Market size	0.967	0.854	0.867	0.910	0.792
4 Health and primary education	11 Business sophistication	0.585	0.500	0.555	0.466	0.450
4 Health and primary education	12 Innovation	0.653	0.574	0.685	0.452	0.558
5 Higher education and training	6 Goods market efficiency	0.629	0.549	0.534	0.681	0.609
5 Higher education and training	7 Labor market efficiency	0.516	0.531	0.561	0.527	0.589

TABLE 17
(Continued)

5 Higher education and training	8 Financial market development	0.682	0.543	0.675	0.754	0.637
5 Higher education and training	9 Technological readiness	0.363	0.342	0.349	0.349	0.464
5 Higher education and training	10 Market size	0.850	0.611	0.708	0.837	0.647
5 Higher education and training	11 Business sophistication	0.667	0.500	0.629	0.613	0.529
5 Higher education and training	12 Innovation	0.565	0.449	0.492	0.556	0.561
6 Goods market efficiency	7 Labor market efficiency	0.460	0.392	0.442	0.419	0.375
6 Goods market efficiency	8 Financial market development	0.407	0.269	0.320	0.419	0.334
6 Goods market efficiency	9 Technological readiness	0.574	0.478	0.502	0.620	0.647
6 Goods market efficiency	10 Market size	0.878	0.754	0.886	0.646	0.582
6 Goods market efficiency	11 Business sophistication	0.414	0.338	0.355	0.424	0.308
6 Goods market efficiency	12 Innovation	0.391	0.460	0.483	0.447	0.306
7 Labor market efficiency	8 Financial market development	0.499	0.476	0.542	0.470	0.420
7 Labor market efficiency	9 Technological readiness	0.497	0.467	0.568	0.417	0.501
7 Labor market efficiency	10 Market size	0.911	0.778	0.847	0.879	0.800
7 Labor market efficiency	11 Business sophistication	0.577	0.493	0.514	0.410	0.426
7 Labor market efficiency	12 Innovation	0.466	0.489	0.501	0.419	0.465
8 Financial market development	9 Technological readiness	0.448	0.497	0.529	0.662	0.574
8 Financial market development	10 Market size	0.792	0.670	0.698	0.700	0.685
8 Financial market development	11 Business sophistication	0.390	0.338	0.424	0.453	0.361
8 Financial market development	12 Innovation	0.381	0.424	0.489	0.473	0.412
9 Technological readiness	10 Market size	0.942	0.804	0.790	0.884	0.741
9 Technological readiness	11 Business sophistication	0.618	0.504	0.657	0.625	0.654
9 Technological readiness	12 Innovation	0.483	0.425	0.543	0.560	0.634
10 Market size	11 Business sophistication	0.772	0.721	0.799	0.744	0.732
10 Market size	12 Innovation	0.798	0.666	0.676	0.680	0.526
11 Business sophistication	12 Innovation	0.318	0.330	0.386	0.222	0.313

TABLE 17

Comparison of the Euclidean distances of all the intercriteria pairs for years 2013–2018

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