THE KNOWLEDGE ECONOMY IN THE EU MEMBER STATES IN THE PERIOD 2007 - 2023

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Abstract

In 2006 researchers of the Faculty of Business Administration, Prague University of Economics and Business created the FBA Innovation Index to analyse the quantitative features of the knowledge economy. For the first time, the index was used in 2007 to analyse the state of the knowledge economy in the European Union member countries. Subsequently, this index was published in 2007, 2013, and 2018. This contribution provides the FBA Innovation Index based on the latest data available (usually from the year 2023). The first part of the paper describes the structure of the Index. In the second part of the contribution, the results obtained from the application of the FBA Innovation Index are compared with the conclusions resulting from the last edition of the European Innovation Scoreboard (2023). The third part of the contribution contains the results that have been achieved for EU-27-member states in a knowledge-based economy, using data for the years 2007, 2013, 2018, and 2022.

Keywords: innovation index, European Union, Czech Republic

JEL Code: O31, O47

1 Introduction

Economics theory and practical economic policy measures convincingly prove that for modern economies, critical drivers of their productivity and global competitiveness are the implementation of new technologies and innovation.

With this in mind, national and international institutions monitor, measure, and compare the innovation performance of individual countries. Let's mention some of them.

The World Intellectual Property Organization publishes the Global Innovation Index (GII). The report ranks economies based on their innovation capabilities. In the 2023 edition, the GII assesses the innovation capability of 132 countries (WIPO 2023).

Bloomberg Innovation Index also provides a global perspective on a country's innovative capacity. The Bloomberg Innovation Index is an annual report that analyses the innovative capacity of 60 economies around the world (Bloomberg 2021).

United Nations does not evaluate a country's innovative capacity from a global perspective. But within their 17 goals of sustainable development, there is Sustainable Development Goal 9, "Industry, Innovation, and Infrastructure," which emphasizes the importance of innovation for sustainable development (UN 2015).

The State New Economy Index (SNEI), published by the Information Technology and Innovation Foundation (ITIF), is a tool that gauges the U.S. member states' capacity to thrive in a technology-driven economy (Atkinson, R. D., & Foote, C. 2022).

The European Innovation Scoreboard (EIS) is prepared under the Directorate-General for Research and Innovation and it compares the research and innovation performance of EU member states, other European countries, and some neighbouring regions (EC, 2023).

All these reports apply, as their main tool, a composite index combining many different data into a single score. Let's compare the structure of EIS and SNEI.

The EIS 2023 captures in total of 32 indicators divided into 4 groups (Framework Conditions, Investments, Innovation Activities, and Impacts). Each group includes an equal number of indicators and has an equal weight in the Summary Innovation Index. Within each group, every indicator has the same weight.

The State New Economy Index (SNEI) uses 25 indicators, which are divided into 5 categories (Knowledge Jobs, Globalization, Economic Dynamism, The Digital Economy, and Innovation Capacity). Indicators weights are different so categories weights are not the same.

Many studies examine the influence of the weight of partial indicators on the overall result of the composite index. The weight of sub-indicators within the GII was analysed by, for example, Huarng, K.-H., & Yu, T. H.-K. (2022) or Oturakci, M. (2021), and within the EIS by Bielińska-Dusza, E., & Hamerska, M. (2021) or Vieira, E. S. (2023). Other studies compare the results of different composite indices. E.g., Belanová, K., Golha, P., & Sivák, R. (2023) compare the results of the EIS and the Regional Innovation Scoreboard with an emphasis on Slovakia.

Our approach is different. The contribution aims to apply the principles of the ITIF methodology to data of the EU member states and then to compare the results received with the results of the EIS. In this way, The EU-27 FBA Innovation Index was created at the Faculty of Business Administration (FBA).

2 Methodology

The FBA Innovation Index was published in the monograph (Kislingerová, E. 2011) for the first time and then in the monograph (Soukup, J. 2015). Subsequently, the FBA Innovation Index was published in 2019 (Soukup, J. 2019).

A scheme that was used to evaluate the knowledge economy in the FBA‘s project was inspired by the Information Technology and Innovation Foundation (Atkinson, R. D., & Foote, C. 2022) methodology but we should underline the fact that both methodological approaches are not completely identical.

The structure of the current EU-27 Innovation Index is evident from Table 1. On the whole, 18 indicators were applied and for their computation, Eurostat data for the year 2022 or the latest available data were applied.

Tab. 1: The Structure of the EU-27 Innovation Index 2022

Indicator	***Weight***
Module A. Knowledge Jobs	***2,50***
Share of managers, professionals, technicians, and associate professionals in total employment from 15 to 64 years (2023)	0,75
Workforce education (2022)	1,00
Labour productivity per person employed and hour worked (EU27=100), 2022	0,75
Module B. Globalization	**1,00**
Exports of high technology products as a share of total exports (2022)	0,75
FDI flows intensity (FDI divided by GDP), 2021	0,25
Module C. Innovation Dynamism	**2,00**
A number of European patent applications (EPO) per 1 mil. inhabitants (2022)	0,5
Number of patents granted by the American USPTO (2020)	1,00
Contribution of electricity from renewables to total electricity consumption (2022)	0,5
Module D. Digital Economy	**1,75**
Level of Internet access – households (%), (2022)	0,50
Individuals using the Internet for interaction with public authorities (%), (2021)	0,50
Share of households with broadband access lines in the total number of households (2021)	0,50
Share of individuals using the Internet to seek health information in the total population (2022)	0,25
Module E. Innovation Capacity	**2,75**
Share of the employment in high and medium-high technology manufacturing in the total employment (2022)	0,75
Human resources in science and technology as a share of the active population – total (2022)	0,75
Share of business enterprises´ gross domestic expenditure on R&D in GDP (2022)	0,75
Share of government and universities´ gross domestic expenditure on R&D in GDP (2022)	0,50
TOTAL	**10**

Note: The indicator Workforce education consists of three partial indices: Persons with lower secondary education attainment (%), from 15 to 64 years (2018) with the weight 1, Persons with upper secondary education attainment (%), from 15 to 64 years (2018) with the weight 1.5, and Persons with tertiary education attainment (%), from 15 to 64 years (2018) with the weight 2.

The score of each country for any partial indicator was calculated with the formula:

$$H_{ij} = (X_{ij} - X_j) / S_{ij} \qquad (1)$$

where Hij is the score achieved by the i-th country in the indicator j, Xij is the original value of the i-th country in the indicator j, Xj is the average value of the j-th indicator for the entire European Union and the Sij is the standard deviation of the j-th indicator.

According to individual indicators, approximately half of the EU members have a negative score (it is below the EU-27 average) and approximately half of the EU members have a positive score (it is above the average of the EU-27). Therefore, the results of all partial indicators are adjusted the same way: number 15 is added to each value. This ensures that the values of all indicators are positive.

Furthermore, the score is calculated in each of the five modules. All indicators have their relative weight. The reason is - again like in the case of the ITF's method - an effort to ensure that the closely related indicators (e.g. a number of patent applications or a number of patents granted) do not affect the overall score significantly.

In the FBA's analysis, the same number of modules as in ITIF's study is used. The relative weight of each module in the FBA project is similar to that in the ITIF analysis.

The total score for the knowledge economy for EU member states was then obtained by a simple summation of scores for individual modules.

The distance between the highest and lowest results is split into four sections. Finally, all 27 countries are divided - according to the total score achieved - into these four groups (quartiles).

A similar procedure is applied in the European Innovation Scoreboard. The performance of EU national innovation systems is measured by the Summary Innovation Index which is a composite indicator obtained by taking an unweighted average of the 32 indicators (the structure of indices, see (EC, 2023). Also, in our analyse, EU countries are divided - according to the total score achieved - into these four groups (quartiles).

The first group (the innovation leaders) includes member states where performance is more than 25% above the EU average. The second group of strong innovators includes member states with a performance between 100% and 125% of the EU average. The third group of moderate innovators includes member states where performance is between 70% and 100% of the EU

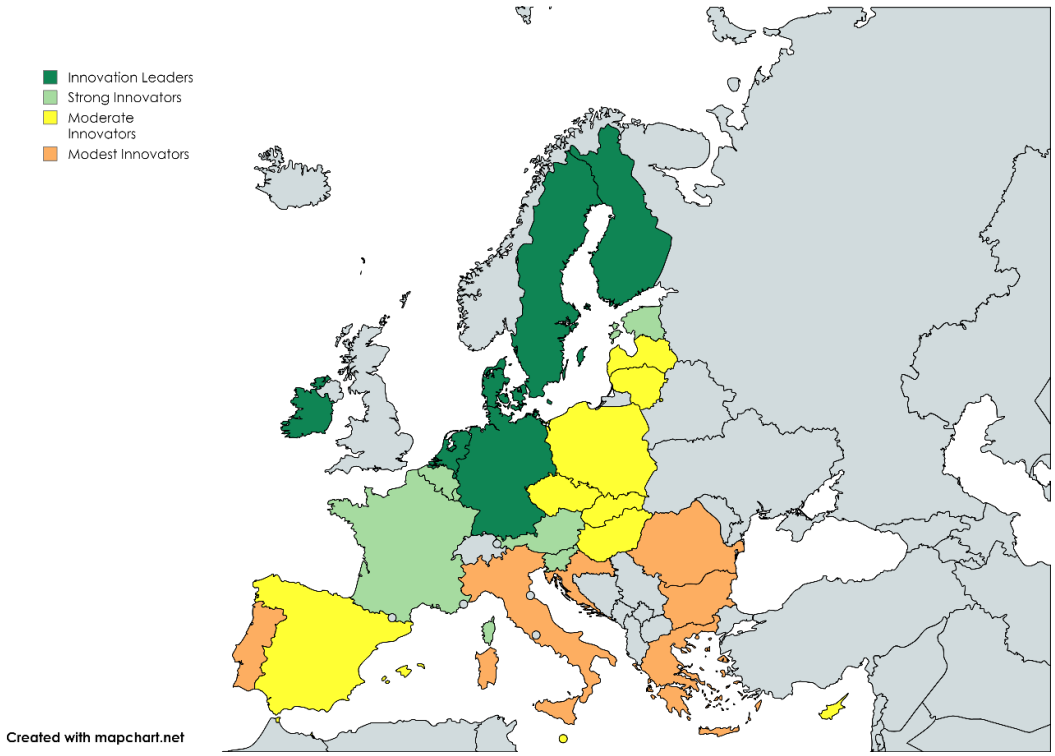
average. The fourth group of emerging or modest innovators includes member states that show performance below 70% of the EU average.

3. Results

In the contribution, we present two results of our investigation. Firstly, we will compare the distribution of EU member states into four groups that were received from the EIS and the FBA's analysis. Figures 1 and 2 provide a visualisation of the differences.

Both indices place the same countries in the first two groups, i.e., innovation leaders and strong innovators. Both indices equally classify Nordic countries (Sweden, Finland, and Denmark) and the Netherlands among innovation leaders. There is also conformity in the ranking of France and Austria among strong innovators. Germany is on the edge of both groups. This is a reason why we can see differences in the assessment of both approaches.

Fig. 1: Innovation Performance according to the FBA Innovation Index



Source: own picture based on the MapChartMap (www.mapchart.net)

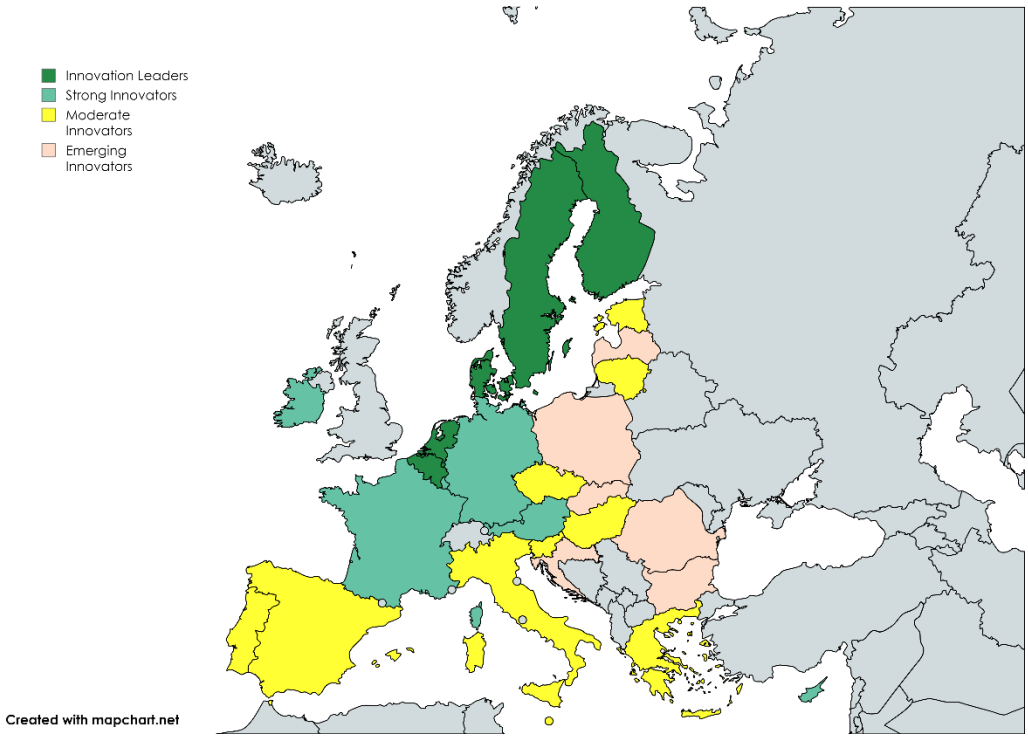
Naturally, both indices also include the same countries in the remaining two groups (moderate and emerging innovators). However, relatively high differences are in the distribution of these countries to both groups.

The EIS and the FBA Innovation Index classify Spain, two Visegrad group (V4) countries (the Czech Republic and Hungary), and two Baltic states (Lithuania and Latvia) as moderate innovators. Also, both indices rank Croatia, Bulgaria, and Romania among emerging or modest innovators.

The difference concerns southern or Mediterranean EU member states (i.e., Portugal, Italy, and Greece). The IES ranks these countries among moderate innovators and the FBA Innovation Index ranks them among emerging innovators. The opposite situation concerns two V4 countries (Slovakia and Poland) and two Baltic states (Lithuania and Latvia). The IES ranks these countries among emerging innovators and the FBA Innovation Index among the moderate innovators.

This difference will require a more detailed analysis. However, the result provided by the FBA Innovation Index shows a higher territorial consistency. The highest innovators are Nordic states together with Germany and Netherlands. The second group consists of Western European countries (France, Belgium, and others), the moderate innovators are the Eastern EU countries (mainly V4 and Baltic countries) and the group of moderate innovators consists of Mediterranean states.

Fig. 2: Innovation Performance according to the European Innovation Scoreboard



Source: own picture based on the MapChartMap (www.mapchart.net) and European Innovation Scoreboard (EIS 2023, p. 11 and p. 12)

Secondly, we will analyse the development of the innovation performance of the EU member states between 2007 and 2022 as shown by the FBA Innovation Index. The results are summarized in Table 2.

Data confirm all four groups of innovators are relatively stable in time. Naturally, some countries on the edge between two groups may find themselves in one group or the other. This is the case in Austria. This country is on the margin between innovation leaders and strong innovators. Computation can rank it as an innovation leader or a strong innovator, depending on the data implemented.

At the same time, the calculations made indicate that the Mediterranean countries (Portugal, Italy, Balkan states) are lagging behind other EU member countries. The pace of innovation activities is behind that of other EU countries.

Tab. 2: The EU-27 Innovation Index 2007 - 2022

	2007	2013	2015	2018	2022
Sweden	2	1	1	2	2
Luxembourg	5	4	2	11	8
Finland	3	3	3	6	5
Denmark	4	5	4	3	4
Netherlands	5	6	5	4	3
Germany	1	2	6	1	6
Austria	7	10	7	5	9
Ireland	10	9	8	8	1
United Kingdom	11	7	9	7	**X**
France	9	8	10	9	10
Belgium	8	11	11	10	7
Estonia	13	12	12	12	11
Slovenia	12	13	13	14	12
Malta	18	17	14	15	17
Czech Republic	15	14	15	13	13
Spain	14	16	16	17	14
Latvia	21	18	17	18	15
Hungary	17	15	18	16	18
Lithuania	22	19	19	21	16
Cyprus	20	21	20	22	19
Slovakia	19	20	21	24	21
Italy	16	22	22	19	23
Croatia	**X**	**X**	23	25	22
Poland	23	23	24	23	20
Portugal	24	24	25	20	24
Greece	25	25	26	27	25
Bulgaria	26	26	27	28	26
Romania	27	27	28	26	27

Note: dark green = innovation leaders, light green = strong innovators, yellow = moderate innovators, orange = emerging / modest innovators
Source: own computation.

4. Conclusions

The first aim of the analysis was to implement the methodology of the American Information Technology and Innovation Foundation (ITIF) evaluating the innovation capacity of the EU member states and compare the results of this analysis with the conclusions of the European Innovation Scoreboard.

The ITIF methodology indicates higher territorial consistency within the EU than the European Innovation Scoreboard. The highest innovators are Nordic states with Germany and Netherlands. The strong innovators are Western European countries, the moderate innovators are Eastern EU countries, and the modest innovators are Mediterranean states.

The second aim was to monitor changes in the innovation capacity of the EU member states in the period 2007 – 2022. The ITIF methodology indicates a relatively stable structure of all four groups over time. At the same time, it indicates that the Mediterranean countries are lagging behind other EU countries.

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Attachment

Module	A	B	C	D	E	Score	Rank	Groupe
Ireland	42,09	17,30	29,90	27,98	43,44	160,71	1	A
Sweden	40,62	14,53	32,50	27,52	44,94	160,12	2	A
Netherlands	39,70	15,13	31,11	29,25	42,97	158,16	3	A
Denmark	39,29	14,49	31,72	27,97	43,93	157,41	4	A
Finland	39,22	14,02	30,82	28,84	43,86	156,76	5	A
Germany	38,41	14,76	35,17	25,20	42,94	156,48	6	A
Belgium	39,72	14,81	29,84	26,90	44,10	155,38	7	B
Luxembourg	42,42	12,76	30,06	28,13	41,92	155,29	8	B
Austria	38,69	14,66	31,16	26,84	43,00	154,34	9	B
France	39,16	14,99	31,21	26,26	41,44	153,06	10	B
Estonia	38,39	14,41	28,94	26,87	42,39	150,99	11	B
Slovenia	38,11	14,05	29,18	26,68	42,34	150,36	12	B
Czechia	37,41	15,18	28,58	26,24	40,68	148,10	13	C
Spain	35,99	14,20	29,77	27,85	40,10	147,90	14	C
Latvia	37,97	14,26	29,44	26,09	39,73	147,48	15	C
Lithuania	39,23	14,15	28,80	25,08	40,15	147,42	16	C
Malta	35,95	16,20	28,72	26,63	39,86	147,35	17	C
Hungary	36,63	14,81	28,50	26,66	40,34	146,94	18	C
Cyprus	38,21	13,27	28,61	27,09	39,72	146,90	19	C
Poland	37,83	14,27	28,74	26,10	39,35	146,29	20	C
Slovakia	37,28	14,11	28,67	25,51	39,33	144,89	21	C
Croatia	36,84	14,07	29,48	24,30	39,10	143,79	22	D
Italy	34,71	14,16	30,23	25,06	38,70	142,86	23	D
Portugal	34,81	13,91	29,72	24,32	39,72	142,49	24	D
Greece	35,59	13,89	29,21	24,36	39,22	142,27	25	D
Bulgaria	35,63	13,94	28,59	23,36	38,33	139,85	26	D
Romania	34,55	14,25	29,19	23,78	36,62	138,38	27	D

Source: own computation, data from the Eurostat database, and data of USPTO (2024).

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