INNOVATION PERFORMANCE ANALYSIS FOR EUROPEAN UNION COUNTRIES FOCUSED ON MODEST INNOVATORS: ROMANIA AND BULGARIA

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ABSTRACT

The aim of this paper is to analyze the innovation performance of Romania, compared to other EU Member States, in order to detect the most significant strengths and weaknesses. There have been used the data provided annually by the European Innovation Scoreboard, namely the Summary Innovation Index (SII), which is a composite index, an aggregation of indicators grouped by dimensions and blocks, to measure the innovation performance at country level. A synthesis of the evolution of the SII since 2001 and analysis of the data in the period 2010-2016 have been performed. The focus was on the Modest innovators cluster – the least performing in innovation group of countries – which includes Bulgaria and Romania. Using a comparative, structural analysis of the SII and its components in both countries, and a time series analysis, the trends, similarities and differences have been identified. A 6-years evolution of the overall innovation performance in Romania has been modelled through linear regression, and the estimation for SII in 2017 was not promising. We've deepened the analysis of the innovation performance in Romania for the period 2010-2016, by studying the evolution of the 10 dimensions of the SII. Data show that 5 dimensions had an increasing evolution, 5 registered a decreasing trend, and 8 of them follow a linear regression model. The conclusions are similar to those obtained in other reports, such as those for competitiveness or doing business rankings. The analysis should be continued at indicator level to obtain a more insightful understanding of the phenomenon.

KEYWORDS: *innovation performance, European Innovation Scoreboard, Summary Innovation Index (SII)*

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1. INTRODUCTION

The **European Innovation Scoreboard (EIS)** is an annual publication aimed to provide a comparative assessment of the innovation performance in EU countries, other European countries and regional neighbors. It was created at the initiative at the European Union, following the Lisbon Strategy and revised after the adoption of the Europe2020 Strategy. The first number was published in 2001, followed by annual editions. In 2010 the report changed its name into the Innovation Union Scoreboard (IUS), but in 2016 it returned to its original name.

The EIS computes yearly the Summary Innovation Index (SII), a composite index meant to offer an overall image on the innovation performance of an economy. In accordance with their SII values, a classification of the EU Member States is performed yearly: the countries are divided into four groups of performance: innovation leaders, strong innovators, moderate innovators, and modest innovators.

The aim of this paper is to offer an insight over the situation of the modest innovators: Bulgaria and Romania. First, the general context has been analyzed: at global (EU average) and local levels (EU Member States), using a comparative analysis for the period 2010-2016. The second analysis refers to the focused modest innovators: several statistical tests have been performed in order to describe the evolution of the two countries over the years in innovation performance, both on global level (using the global SII indicator) and on structural level (based on the pillars composing the SII indicator). The approaches taken are considered the first step in a more comprehensive analyze of the innovation performance of the modest innovators countries, analyze dedicated to finding ways to reduce the gaps between countries.

2. THE SUMMARY INNOVATION INDEX (SII)

The innovation performance is measured through several indicators – grouped into ”dimensions” and ”blocks” – that have been integrated into a composite index: the **Summary Innovation Index (SII)**.

The 2017 European Innovation Scoreboard uses an aggregation of 27 indicators, grouped into 10 dimensions, in 4 blocks (Figure 1).

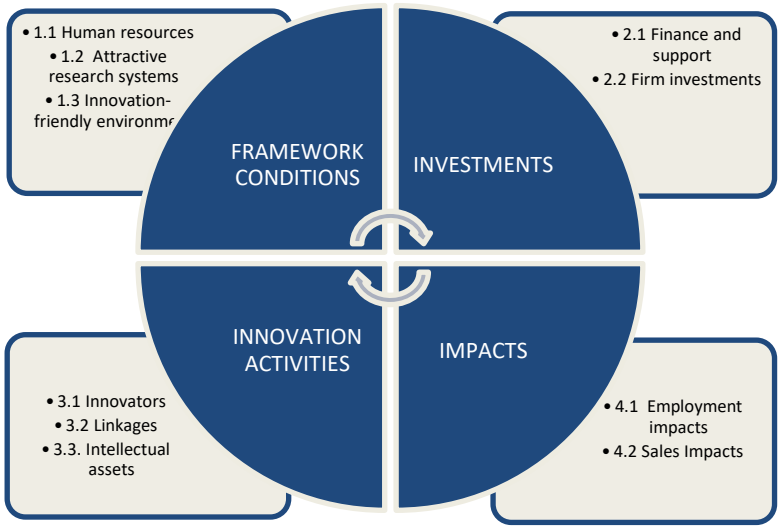

Figure 1. The structure of the Summary Innovation Index (SII) in 2016
(Source: chart made by the authors using MS Excel, based on data published in EIS 2017)

The structure of the Summary Innovation Index has changed over time, with major revisions in 2005, 2010 and 2017 (see Table 1).

Table 1. The evolution of the Innovation Scoreboard
(Source: made by the authors based on data published in EIS 2001- EIS 2017)

Scoreboard Name	Year	Clusters of countries based on innovation performance	SII structure		
			Number of indicators	Number of dimensions	Number of blocks of dimensions
EIS	2001	Moving-ahead Catching-up Falling further behind Losing momentum	17	4[1]	1
	2002	Same as in 2001	17	4	1
EIS	2003	Same as in 2002	19	4	1
	2004	Same as in 2003	20	4	1
	2005	Leading countries Average performance Catching-up Losing ground	26	5	2[2]
	2006	Innovation leaders Innovation followers Catching up countries Trailing	25	5	2
	2007	Innovation leaders Innovation followers Moderate innovators Catching-up countries	25	5	2

	2008	Same as in 2007	29	7	3[3]
	2009	Same as in 2008	29	7	3
IUS	2010	Innovation leaders Innovation followers Moderate innovators Modest innovators	25	8[4]	3
	2011 2013- 2015	Same as in 2010	25	8	3
EIS	2016	Innovation leaders Strong innovators Moderate innovators Modest innovators	25	8	3
	2017	Same as in 2016	27	10	4[5]

[1] Human resources for innovation / The creation of new knowledge / The transmission and application of knowledge/ Innovation finance, outputs and markets

[2] **Innovation Inputs** (Innovation drivers; Knowledge creation; Innovation and entrepreneurship) / **Innovation Outputs** (Application; Intellectual property)

[3] **Enablers** (Human resources; Finance and support) / **Firm activities** (Firm investments; Linkages and entrepreneurship; Throughputs) / **Outputs** (Innovators; Economic effects)

[4] **Enablers** (Human resources; Open, excellent and attractive research systems; Finance and support) / **Firm activities** (Firm investments; Linkages and entrepreneurship; Intellectual assets) / **Outputs** (Innovators; Economic effects)

[5] **Framework conditions** (Human resources; Attractive research systems; Innovation-friendly environment) / **Investments** (Finance and support; Firm investments) / **Innovation activities** (Innovators; Linkages; Intellectual assets) / **Impacts** (Employment impacts; Sales impacts)

3. EUROPEAN UNION MEMBER STATES RANKING

Based on the Summary Innovation Index, the European Innovation Scoreboard publishes yearly a ranking of the European Union Member States and some other European countries. Based on this ranking, the EU Member States are classified into 4 performance clusters (see Table 1).

The ranking proposed by EIS 2017 is:

- *Innovation leaders*, including countries with innovation performance well above that of the EU average. The Innovation leaders are: Sweden, Denmark, Finland, the Netherlands, Germany, and the United Kingdom;
- *Strong innovators*, including countries with innovation performance below those of the innovation leaders but close to or above that of the EU average. The group of the *Strong innovators* includes the following six countries: Austria, Belgium, France, Ireland, Luxembourg, and Slovenia;

- *Moderate innovators*, including countries with innovation performance below that of the EU average. The *Moderate innovators* are: Croatia, Cyprus, the Czech Republic, Estonia, Greece, Hungary, Italy, Latvia, Lithuania, Malta, Poland, Portugal, Slovakia, and Spain;
- *Modest innovators*, where the innovation performance is well below the EU average, includes Bulgaria and Romania.

Figure 2 shows the four clusters of countries according to EIS 2017 (with the most innovative country in the right side and the less innovative one to the left).

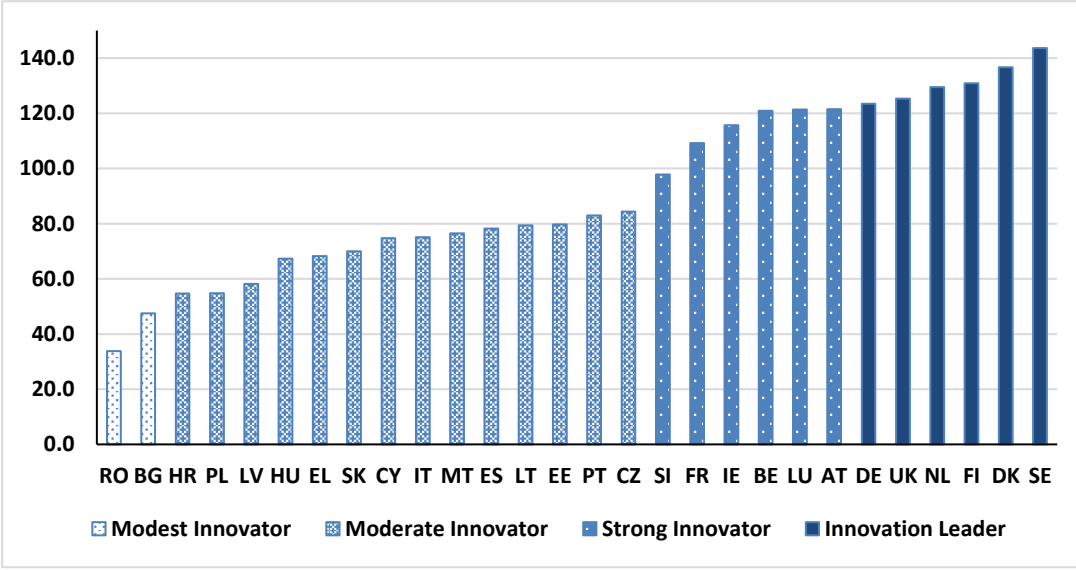

Figure 2. The clusters of EU Member States in innovation performance in 2016.
(Source: chart made by the authors using MS Excel, based on data published in EIS 2017)

4. EVOLUTION OF THE INNOVATION PERFORMANCE IN EU IN THE PERIOD 2010-2016

The average Summary Innovation Index on EU level has had an unstable evolution in the period 2010-2016, as Figure 3 shows, but taking into consideration the 2010 level of 100 and the 2016 level of 102, we can observe that the average level of innovation performance has increased with 2 percentage points.

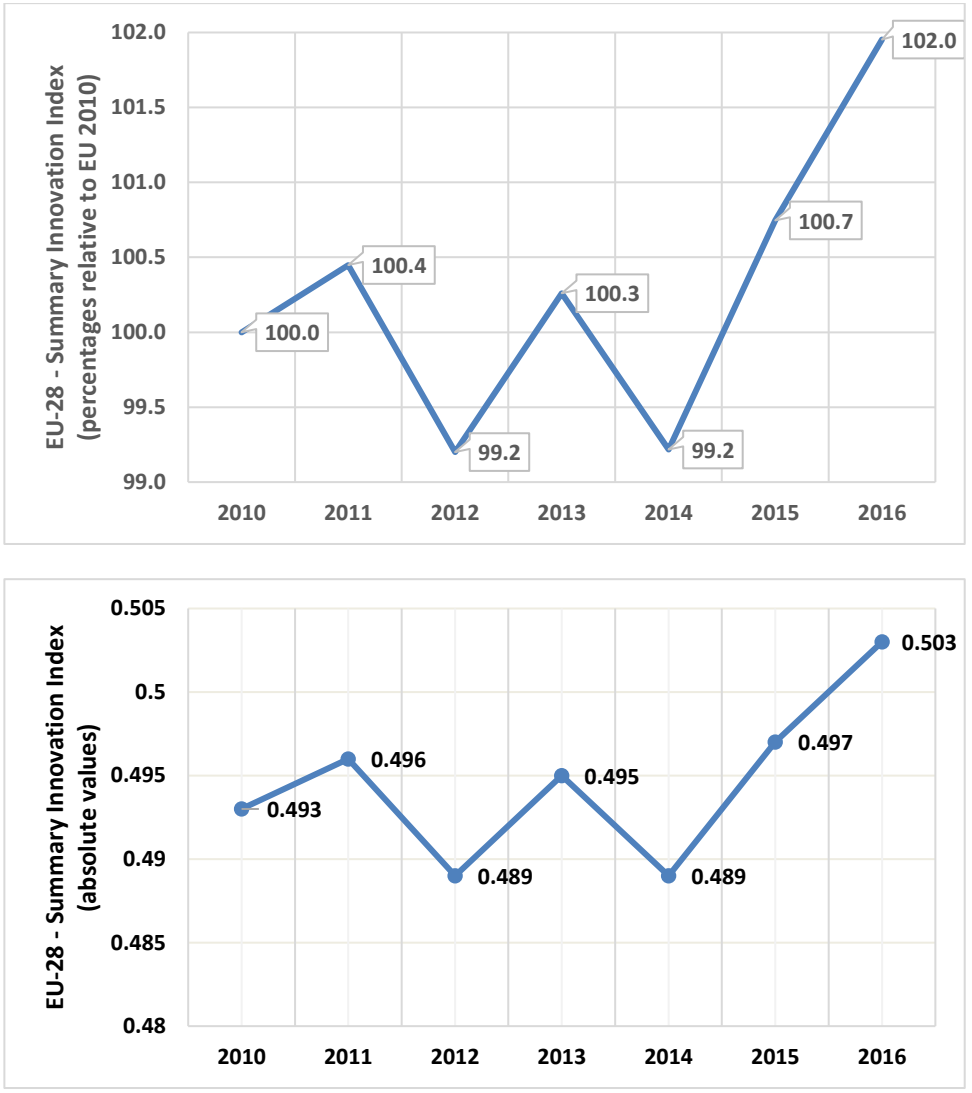

Figure 3. The dynamics of Summary Innovation Index average for the 28 EU Member States in the period 2010-2016
(Source: chart made by the authors using MS Excel, based on data published in EIS, 2017)

But EIS 2017 observes that "performance has increased for the EU but not for all Member States". Indeed, reconsidering the 2016 ranking opposed to the national levels in 2010, the situation in Europe is as Figure 4 shows.

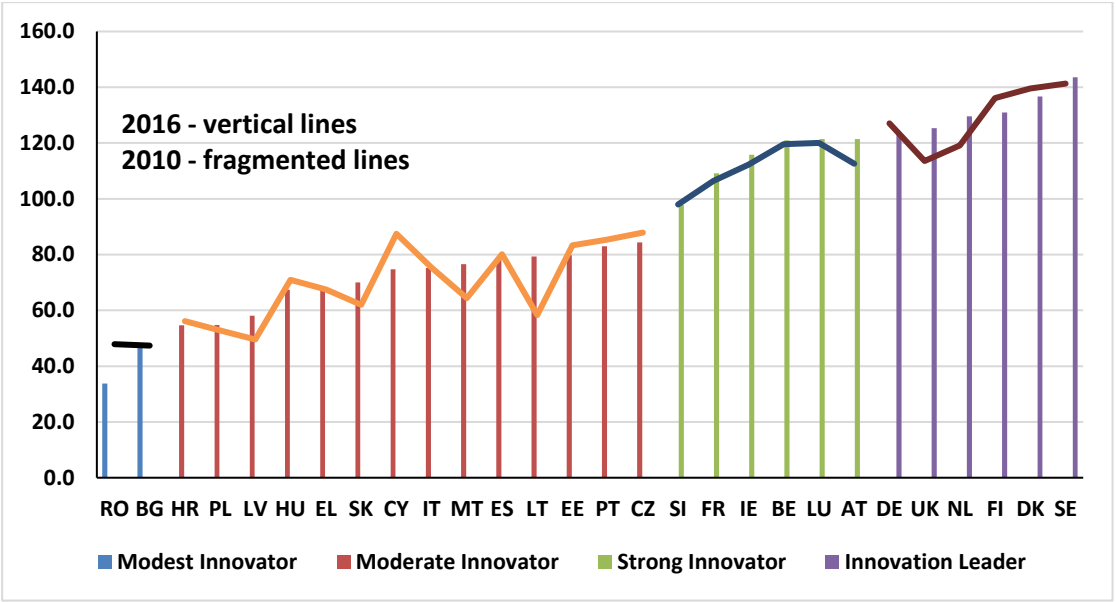

Figure 4. The clusters of EU Member States in innovation performance in 2016. Comparative analysis 2016 versus 2010
(Source: chart made by the authors using MS Excel, based on data published in EIS 2017)

Indeed, some countries have fostered their innovation level in the last 6 years: Lithuania registered a 136% increase of the innovation performance, while Latvia and Malta reached slightly below 120%. Most of the EU countries maintained their innovation level.

On the other side of the spectrum are Cyprus having 85.5% in 2016, reported to the 2010 value, in innovation performance, and Romania, which registers a dramatic drop in innovation performance, having in 2016 only 70.6% of the 2010 value.

5. ANALYSIS OF THE INNOVATION PERFORMANCE IN THE *MODEST INNOVATORS* GROUP IN THE PERIOD 2010-2016

The innovation performance in Romania and Bulgaria is analyzed in EIS since 2004. Each year, the two countries belonged to the least performing innovation cluster, and since 2015, Romania ranks last in the SII classification.

The evolution of the two neighboring countries is rather different: Bulgaria has a fall in 2012, but it recovers in the following year and after that, it registers a constant progress. On the other hand, Romania has a similar fall in 2012, but after that, it continues to decrease to a dramatic 32 value in 2015, followed by a short recover in the last year of the analysis.

The 6-years evolution in Romania has been modelled through linear regression. The R^2 = 0.89 shows a very strong relationship between data, and the linear equation is:

$$SII = -3.08 \times Year + 52.67$$

Additional tests have been performed in order to confirm the accuracy of the linear model.

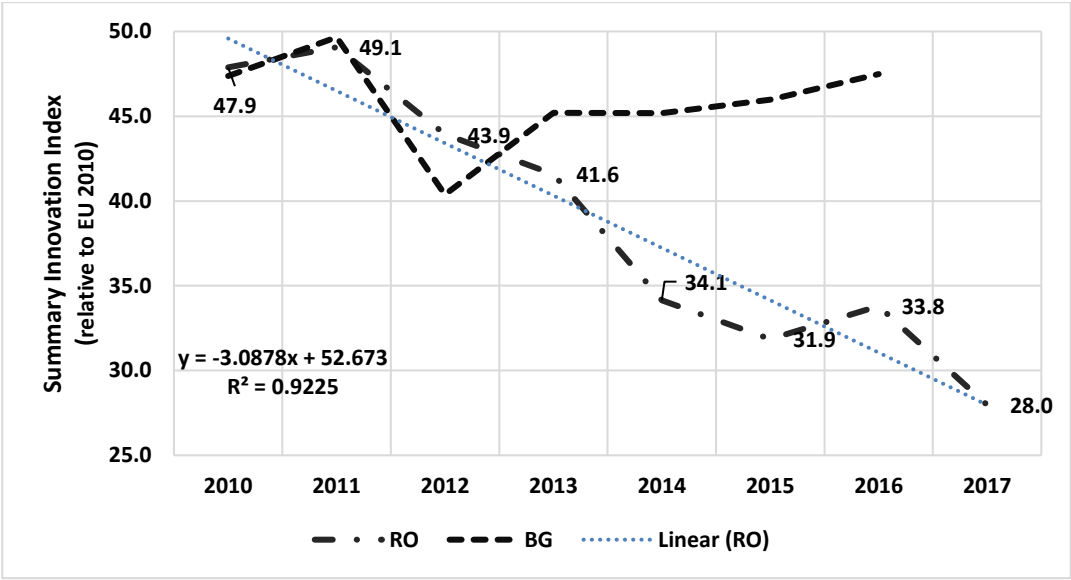

Figure 5. The dynamics of the innovation performance in the period 2010-2016 for the Modest innovators countries. The 2017 value for Romania is estimated using the linear model. (Source: chart made by the authors using MS Excel, based on data published in EIS 2017)

The linear model provides a good estimation for the following year of the analysis: estimation for 2017 is below the value of 28, a dramatic lowest value ever.

On structural level, the innovation performance in 2016 for the Modest innovators – Romania and Bulgaria – is presented in Figure 6 and 7.

In the FRAMEWORK CONDITIONS area, there are two dimensions where Bulgaria has better results in innovation performance terms than Romania: Human resources (1.1) and Attractive research systems (1.2 except for 1.2.2 – Scientific publications among top 10% most cited). But in terms of Innovation-friendly environment (1.3), the situation changes, Romania having significantly better results.

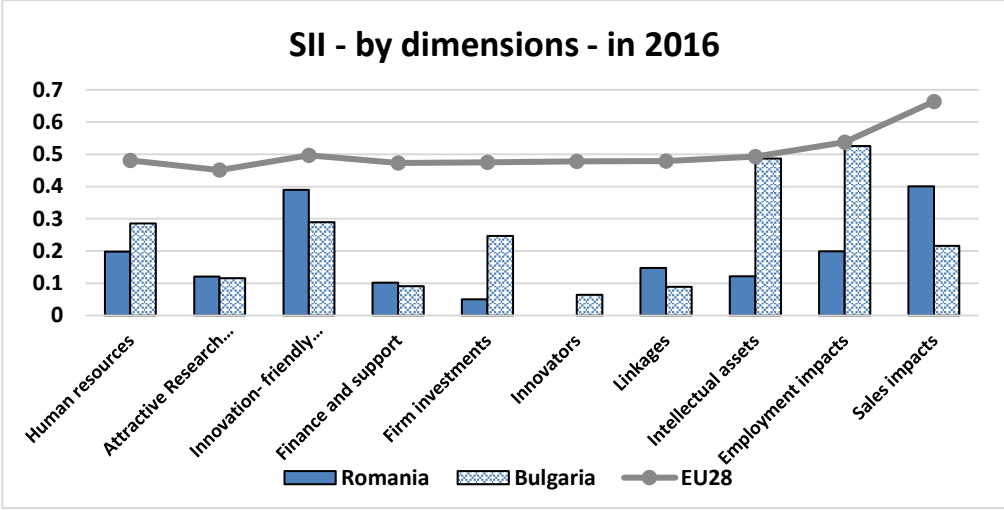

Figure 6. Comparison of the innovation performance between the Modest innovators countries in 2016 (SII by dimensions)
(Source: chart made by the authors using MS Excel, based on data published in EIS 2017)

Regarding the INVESTMENTS and INNOVATION ACTIVITIES areas, Bulgaria is leading again, except of some isolated domains (2.1.1 – R&D expenditure in the public sector, 3.2.2 – Public-private co-publications, and 3.2.3 – Private co-funding of public R&D expenditures) where Romania is better positioned.

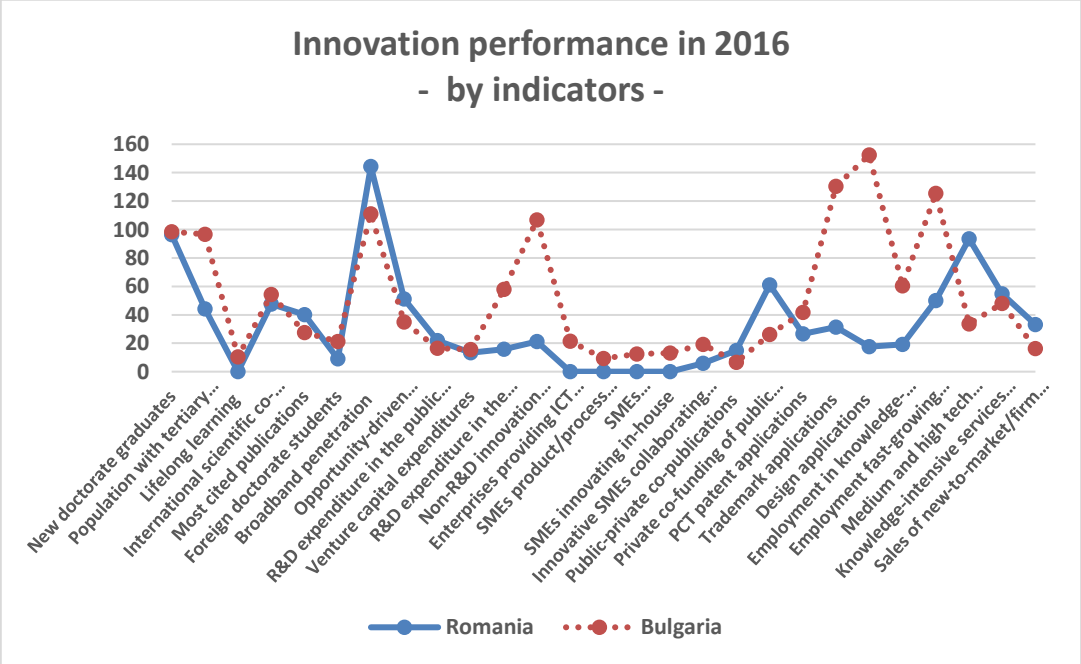

Figure 7. Comparison of the innovation performance on structural level (SII by indicators) between the Modest innovators countries in 2016
(Source: chart made by the authors using MS Excel, based on data published in EIS 2017)

The IMPACTS area is equally split between the two countries: Romania is leader in the Sales impacts (4.2), whilst Bulgaria leads the Employment impacts (4.2) subdomain.

The dynamics of change 2010-2016 in the two Modest countries is presented in Figure 8. The SII indicator decreased by 14.1 percent in Romania, while it increased by 0.1 percent in Bulgaria. The most significant decreases have been observed in Romania for the following dimensions: ”Firm investments”, ”Finance and support”, ”Innovators”, ”Linkages” and ”Sales impacts”.

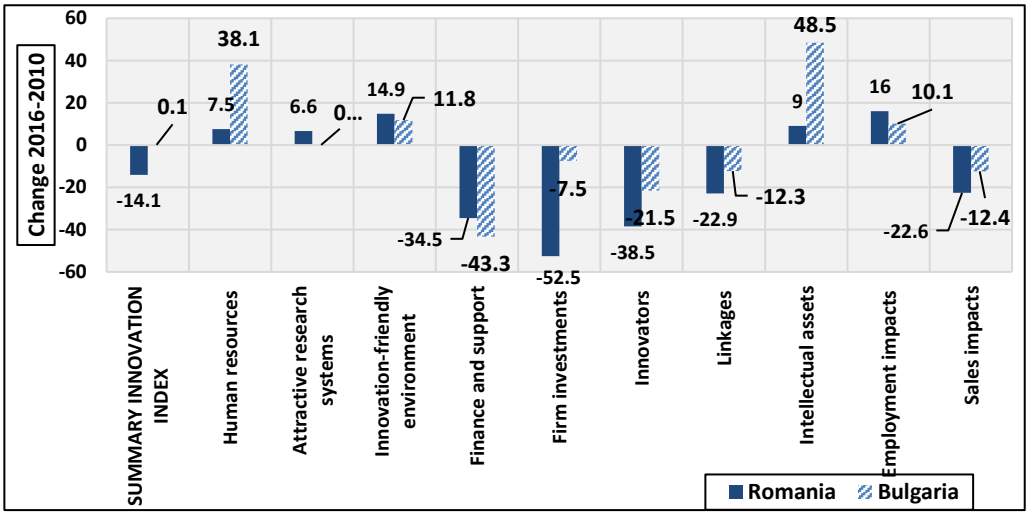

Figure 8. Comparison of the dynamics of innovation performance in 2016 versus 2010 (SII by dimensions) between the Modest innovators countries
(Source: chart made by the authors using MS Excel, based on data published in EIS 2017)

6. FURTHER ANALYSIS OF THE INNOVATION PERFORMANCE IN ROMANIA

The aim of this section is to deepen the analysis of the innovation performance in Romania, by dimensions. Using EIS 2017 database, we have analyzed the evolution of the 10 dimensions of the SII index in the last 6 years, in order to investigate which of them could be optimized so that the dramatic situation in Romania would improve.

Romania registered a constant (increasing) evolution in some dimensions, such as: Human resources (1.1), Research systems (1.2), Innovation-friendly environment (1.3), Intellectual assets (3.3), and Employment impacts (4.1) (Figure 9).

Worth mentioning that some of these dimensions follow a linear evolution described in Table 2.

Table 2. Linear model parameters for some dimensions of the SII for Romania in the period 2010-2016
(Source: computed by the authors using MS Excel, based on data published in EIS 2017)

	FRAMEWORK CONDITIONS	INNOVATION ACTIVITIES	IMPACTS
Pillar	**Innovation-friendly environment (1.3)**	**Intellectual assets (3.3)**	**Employment impacts (4.1)**
Slope	2.27	1.12	2.11
Intercept	69.89	16.34	17.83
R^2	0.73	0.80	0.76

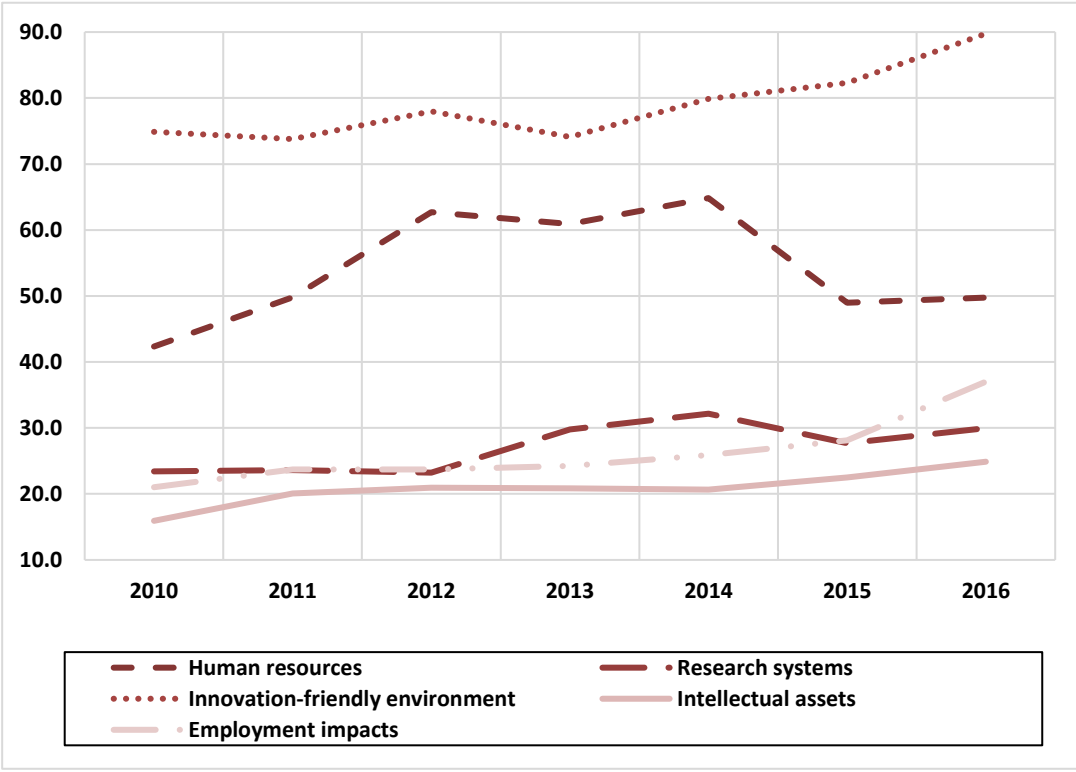

Figure 9. Increasing behavior at structural level of the innovation performance of Romania in the period 2010-2016
(Source: chart made by the authors using MS Excel, based on data published in EIS 2017)

Some other dimensions are characterized by a decreasing evolution (Figure 10). They are:

- Finance and support (2.1) and Firm investments (2.2), the two components of the INVESTMENTS area;
- Innovators (3.1) and Linkages (3.2), two of the three components of the INNOVATION ACTIVITIES area;
- Sales impacts (4.2), the second component of the IMPACTS area.

Worth mentioning that all the above dimensions follow a linear evolution described in Table 3.

Table 3. Linear model parameters for some dimensions of the SII for Romania in the period 2010-2016
(Source: computed by the authors using MS Excel, based on data published in EIS 2017)

	INVESTMENTS		INNOVATION ACTIVITIES		IMPACTS
Pillar	**Finance and support (2.1)**	**Firm investments (2.2)**	**Innovators (3.1)**	**Linkages (3.2)**	**Sales impacts (4.2)**
Slope	-7.09	-9.61	-6.41	-4.91	-5.88
Intercept	60.94	68.41	46.05	62.36	95.42
R^2	0.92	0.76	0.93	0.85	0.67

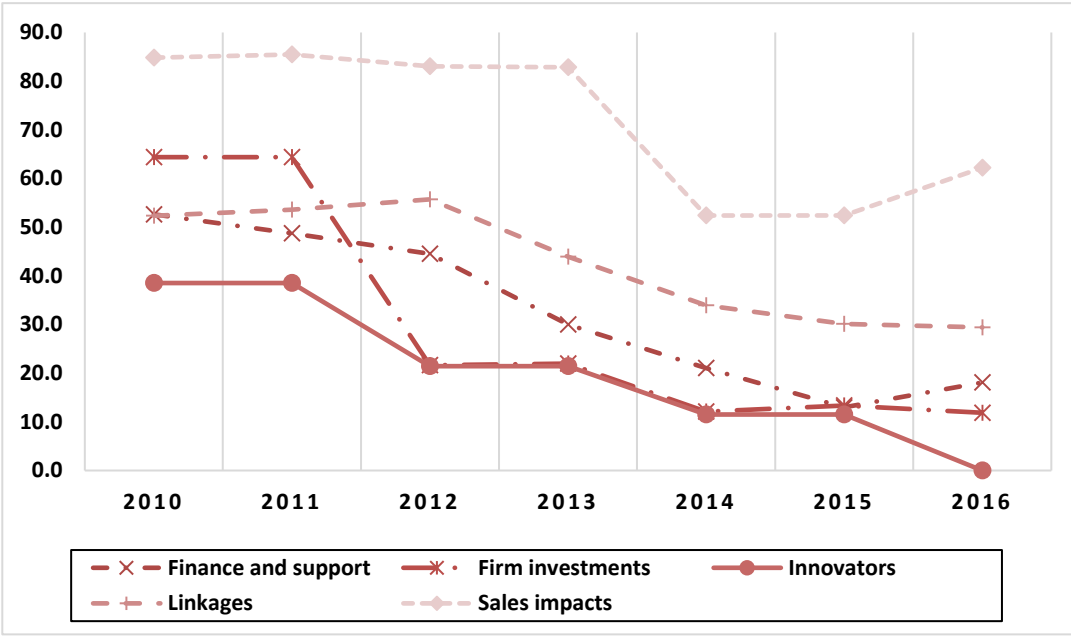

Figure 10. Decreasing behavior at structural level of the innovation performance of Romania in the period 2010-2016
(Source: chart made by the authors using MS Excel, based on data published in EIS 2017)

7. CONCLUSIONS

For years, Romania and Bulgaria are among the modest innovators countries in European Union. We have tried to analyze the innovation performance in those two countries, reporting it to the EU global situation.

Below is presented a synthesis of the studies that have been performed together with the corresponding conclusions:

- Study on the evolution of the average innovation performance in EU in the period 2010-2016 – the evolution is fragmented, but has increased in the last 2 years;
- Study on the evolution of the innovation performance for the EU 28 Member States, grouped into 4 groups of performance, the 2016 situation related to the 2010 – as EC states, "performance has increased for the EU but not for all Member States";
- Analysis on the innovation performance in the Modest innovators group in the period 2010-2016: after 2012, Bulgaria registers a constant progress, while Romania is steadily decreasing, except for the last year of the analysis;
- Modeling through linear regression the innovation performance in Romania in the period 2010-2016: the linear model provides a good estimation for 2017 below the value of 28, a dramatic lowest value ever;
- Comparative analyzes on the innovation performance on structural level for the Modest innovators group in 2016 – first analysis uses the 10 pillars, the second the 27 indicators. For some pillars, Romania is leading, for some other Bulgaria;
- Analysis on structural level (the 10 pillars) of the dynamics of the innovation performance in Romania in the period 2010-2016: for some pillars, Romania is registering an increasing behavior, while for some others, the effect is opposite;
- Linear modeling of some dimensions of the SII for Romania in the period 2010-2016: for some pillars the evolution is linear. The models can be used for forecasting the future behavior.

REFERENCES

[1] COM (2010) 546 final, "Europe 2020 Flagship Initiative Innovation Union". Available at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:0546:FIN:EN:PDF;

[2] COM (2010) 2020 final, "EUROPE 2020 - A strategy for smart, sustainable and inclusive growth". Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:2020:FIN:EN:PDF;

[3] Crișan D. A., "Data analyses of the connection between IT&C and the economic performance in European Union. Study case: Romania", Romanian Economic and Business Review (REBE), Vol 10 No 2, 2015 , pp. 130-139, Ed. ProUniversitaria, ISSN 1842 – 2497, 2015;

[4] Crișan D. A., Crișan M. C., Grigore O.T., Băluță R., "Classification tree for modelling the relationship between IT&C and the economic development for the EU-28 Member States", Romanian Economic and Business Review (REBE), Vol 10 No 4, 2015 , pp.22-33, Ed. ProUniversitaria, ISSN 1842 – 2497, 2015;

[5] Crișan D. A., Stănescu E. D., Usta A., "The relationship between IT&C and the economic development for the EU-28 Member States", Romanian Economic and Business Review (REBE), Vol 10 No 4, 2015 , pp.34-43, Ed. ProUniversitaria , ISSN 1842 – 2497, 2015;

[6] Crișan D.A., Potecea O., Preda A.M., Stănică J.L., "ICT determining factors in increasing the innovation in Romania", Journal of Information Systems and Operations Management (JISOM), Vol. 5 No. 1 / May 2011, Ed. Universitara, pp. 94-99, 2011;

[7] Crișan D.A., Preda A.M., Coculescu C., Altăr-Samuel A.N., "Some aspects concerning the correlation between ICT and innovation in Europe", Journal "Annals of the University of Oradea: Economic Science", vol I, issue 2, pp. 1183-1189, 2010;

[8] European Commission (2001), "2001 Innovation Scoreboard", Available at http://ec.europa.eu/regional_policy/archive/innovation/pdf/library/innovation_scoreboard.pdf;

[9] European Commission (2006), "European Innovation Scoreboard 2005 – Comparative Analysis of Innovation Performance", Available at http://www.astrid-online.it/static/upload/protected/Euro/European-Innovation-Scorebord-12_01_.pdf;

[10] European Commission (2016), "European Innovation Scoreboard 2016". Available at http://ec.europa.eu/DocsRoom/documents/17822;

[11] Hollanders H., Es-Sadki N., "European Innovation Scoreboard 2017", 2017, Available at http://ec.europa.eu/DocsRoom/documents/24829;

[12] Preda A.M., Crișan D. A., Stănică J.L., "The Impact of ICT on Innovation Performance in Europe. Case of Romania", Journal of Information Systems and Operations Management (JISOM), Vol 8 No 1, 2014, pp. 1-12, Ed. Universitara, 2014;

[13] Preda A.M., Crișan D. A., Stănică J.L., Altăr Samuel A.N., "Transectional Analysis between Innovation and ICT Readiness for the European Union Countries", Journal of Information Systems and Operations Management (JISOM), Vol 10 No 2, 2016, pp.393-403, Ed. Universitara ISSN 1843-4711, 2016;

[14] Preda A.M., Crișan D.A., Potecea O.,"A study on the relationship between ICT and innovation in Europe", The 17th International Economic Conference – IECS 2010 "Economic world's destiny: Crisis and Globalization", May 13-14, 2010, Univ. Lucian Blaga, Sibiu, Romania, Conference Proceedings, pp.178-183 (CD Version), 2010;

[15] Preda A.M., Crişan D.A., Stănică J.L., "Modeling the impact of ICT on innovation performance", presented at the 19th International Economic Conference – IECS 2012, "The persistence of the global economic crisis: causes, implications, solutions", June 12 2012, Univ. Lucian Blaga, Sibiu, Romania, published in Conference Proceedings: (CD Version), 2012;

[16] PRO INNO Europe® (2008), "European Innovation Scoreboard 2007 Comparative Analysis of Innovation", Available at https://publications.europa.eu/en/publication-detail/-/publication/71bca3b1-ec59-4172-ac6c-e294acd15bd9/language-en/format-PDF;

[17] PRO INNO Europe® (2009), "European Innovation Scoreboard 2008 Comparative Analysis of Innovation Performance", Available at https://publications.europa.eu/en/publication-detail/-/publication/13f52081-c6e5-46ac-8ac1-8f3fc01538b6/language-en/format-PDF;

[18] PRO INNO Europe® (2011), "Innovation Union Scoreboard (IUS 2010)", Available at https://publications.europa.eu/en/publication-detail/-/publication/b81a4ca8-2d8d-4a77-9a55-0b49962b74d0/language-en/format-PDF;

[19] Tarantola S., Gatelli D., Hollanders H., "European Innovation Scoreboard 2006 Comparative Analysis of Innovation", Joint Research Center - European Commission, 2007, Available at http://publications.jrc.ec.europa.eu/repository/bitstream/JRC36794/reqno_jrc36794_final[2].pdf.