ORIGINAL PAPER

STATE HIRSCH INDEX RANK FOR THE EVALUATION OF THE SCIENTIFIC RESEARCH PERFORMANCE IN THE FIELD OF CHEMISTRY

SILVIU JIPA[1], LAURA MONICA GORGHIU[1], CRINELA DUMITRESCU[1], CALIN OROS[1]

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Abstract. *The Hirsch index is an indicator used to measure both the productivity and impact of a country's published scientific work. The current paper examines the Country Rank in the field of Chemistry and Chemical Engineering in Romania (1996 – 2010) using data from SCImago Journal and Country Rank.*

Keywords: *research, Scientometrics, Hirsch index, influence score.*

1. INTRODUCTION

Scientific research represents an essential component of the activity performed by the academic staff within the university. It holds an important share from the academic activities and plays a decisive role in the appraisal of professional performance and academics' prestige.

Romania's entry into the European Union on 1st of January 2007 has brought about a number of problems related to the chemical industry in our country because, on the one hand, the imports from the EU outnumbered the exports and, on the other hand, these continued to drop. This industry is considered to be of a low level of productivity and competitiveness [1,2]. Oltchim S.A. Chemical Works are known to have been going through a process of decline since the early 2009, the causes for this being mainly political while its privatization is being done under the pressure exerted by the International Monetary Fund.

Research and innovation constitute the priority goals of the European strategy for economic growth and employment. The member states are urged to invest 3% of their GDP into research and development by the year 2020 (1% public funds, 2% private investments). This is estimated to possibly result in 3.7 million jobs and to determine a GDP's annual growth by approximately 800 billion Euros [3].

Re-engineering and innovation are activities which have called on the rapid development of scientific research in this domain. EU is making efforts to establish, by the year 2014, only one European Research Space that would enable researchers to work in any EU country and would intensify trans-boundary cooperation.

Therefore, scientific research is performed in accordance with the university's strategy for Development - that lies on the basis of the national and European strategic programmes regarding scientific research, technological development and innovation - and all these are embodied in the university's Scientific Research Programme.

Today the Hirsch index is used to evaluate the scientific activity of an individual, a community, an institution or a country as well as to rank all [4-7].

[1] Valahia University of Targoviste, Faculty of Sciences and Arts, 130082 Targoviste, Romania.
E-mail: jipasilviu@yahoo.com.

The current paper intends to present the scientific research performance of various countries in the field of Chemistry and chemical engineering as shown by Hirsch indices they have scored.

2. MATERIALS AND METHODS

We have analyzed Romania's performance in the field of Chemistry and Chemical Engineering between 1996-2010, relative to the ex-communist neighboring countries and some developed countries using the Hirsch index as an evaluation indicator. The performances are discussed on the whole but also in each branch: Analytical Chemistry, Inorganic Chemistry, Organic Chemistry and Physical Chemistry. We have used data collected from the SCImago Journal & Country Rank [8]. This journal provides a country scientific indicator developed from the information contained in the Scopus Database.

3. RESULTS AND DISCUSSIONS

According to the site of SCImago Journal & Country Rank, the number of the scientific papers in the field of chemistry and chemical engineering in Eastern Europe between 1996-2010 was 243,946, of which 14,896 represent Romanian contributions (6%). The countries with a large number of papers in the field of chemistry and chemical engineering are listed in the Table 1. Eastern European countries are presented in Table 2.

As for the Hirsch index, Romania ranks 46th in the world and 21st in the EU with a value of 117, after Poland, Hungary, the Czech Republic and Bulgaria.

Table 1. Countries with a large number of papers in the field of Chemistry and Chemical Engineering (1996-2010).

Item no.	Country	No. of papers on Chemistry	No. of papers on Chemical Engineering	Hirsch index
1	United States of America	279334	123428	1229
2	United Kingdom	88142	33139	750
3	Germany	121699	45011	657
4	France	87845	33230	604
5	Canada	42625	23423	580
6	Japan	150454	60678	568
7	Italy	57137	19154	515
8	Netherlands	23025	13002	509
9	Switzerland	24748	7540	506
10	Sweden	20084	9181	448
11	Spain	62203	20062	412
12	Belgium	17736	6491	398
13	Denmark	9641	3996	373
14	Austria	11105	3706	336
15	Finland	8502	5697	330
16	China	176779	109995	316
17	Norway	5107	3866	288
18	Brazil	24064	11794	262
19	India	74204	30053	256

Analytical Chemistry is the branch of chemistry that deals with the qualitative and quantitative analysis of chemical elements, their compounds and various materials. Table 3 shows Top 10 of the East European countries that have papers on Analytical Chemistry.

Inorganic Chemistry is the branch of chemistry that is concerned with the study of chemical elements and their compounds with the exception of some carbon compounds. Carbon mineral compounds (oxides, carbonates, metallic carbides) make the object of inorganic chemistry. Table 4 presents the Top 10 of East European countries with papers in inorganic chemistry.

Table 2. Papers of East European countries in the field of Chemistry and Chemical Engineering (1996-2010).

Item no.	Country	No. of papers on Chemistry	No. of papers on Chemical Engineering	Hirsch index
1	Russian Federation	80806	21077	285
2	Poland	32594	12287	258
3	Hungary	11260	3966	224
4	Czech Republic	14186	3873	206
5	Slovakia	4920	1378	131
6	Slovenia	4203	1445	127
7	Bulgaria	4852	2272	121
8	Ukraine	12231	4578	121
9	Croatia	3518	1546	118
10	Romania	9450	5446	117
11	Estonia	1335	458	111
12	Lithuania	1770	525	96
13	Armenia	762	116	90
14	Belarus	3887	1180	90
15	Latvia	1023	288	76
16	Georgia	573	147	70
17	Moldova	790	56	51
18	Macedonia	512	126	48
19	Serbia	1668	665	42
20	Bosnia and Herzegovina	81	68	36
21	Albania	50	10	33
22	Azerbaijan	854	281	36
23	Montenegro	11	8	8

Table 3. Top 10 of East European countries with papers on Analytical Chemistry [8] (1996-2010).

Item no.	Country	No. of papers	Citations	Hirsch index
1	Poland	6059	59865	69
2	Czech Republic	3014	42428	67
3	Russian Federation	4475	34383	63
4	Hungary	2635	28388	56
5	Slovenia	788	10478	45
6	Slovakia	813	9165	40
7	Ukraine	743	7022	39
8	Bulgaria	624	7330	37
9	Romania	1031	8787	37
10	Lithuania	444	6162	36

Table 4. Top 10 of East European countries with papers in Inorganic Chemistry [8] (1996-2010).

Item no.	Country	No. of papers	Citations	Hirsch index
1	Russian Federation	10568	42492	51
2	Hungary	1250	13769	46
3	Poland	4104	29768	45
4	Czech Republic	1547	15125	39
5	Slovakia	484	4242	29
6	Romania	616	4770	28
7	Ukraine	1414	5855	26
8	Slovenia	355	3174	25
9	Bulgaria	390	2921	22
10	Belarus	297	872	15

Organic Chemistry is the branch of chemistry that involves the study of hydrocarbons and their derivatives. Table 5 illustrates the Top 10 of Eastern European countries with papers in the field of organic chemistry.

Table 5. Top 10 of East European countries with papers in the field of Organic Chemistry [8] (1996-2010).

Item no.	Country	No. of papers	Citations	Hirsch index
1	Russian Federation	12538	51928	63
2	Poland	4585	45292	58
3	Czech Republic	2053	24645	55
4	Hungary	2167	23084	48
5	Ukraine	2258	9205	37
6	Bulgaria	640	6825	36
7	Romania	898	8665	35
8	Slovakia	762	8127	34
9	Slovenia	603	7032	34
10	Croatia	498	4506	27

Physical Chemistry is the discipline within chemistry that studies in terms of methods and laws of physics the causes of the chemical phenomena and the laws that govern these. Table 6 shows the Top 10 of East European countries with papers in physical chemistry.

Table 6. Top 10 of East European countries with papers in the field of Physical Chemistry [8] (1996-2010).

Item no.	Country	No. of papers	Citations	Hirsch index
1	Russian Federation	23274	121647	81
2	Poland	10369	100875	79
3	Czech Republic	3756	44721	70
4	Hungary	3731	40804	59
5	Ukraine	3498	25229	52
6	Bulgaria	1734	18165	45
7	Romania	1562	15423	45
8	Slovakia	1249	13890	45
9	Belarus	901	8020	41
10	Slovenia	891	10557	44

Industrial Chemistry is that branch of chemistry which deals with the application of data and chemical or physical-chemical laws to industrial processes in order to obtain chemical products. Raw materials such as oil, natural gas, metals and minerals are converted into numerous finished goods. This industry involves the use of complex equipment and logistic systems which are sometimes complicated and dangerous. Table 7 presents the Top

10 of Eastern European countries with papers in the field of chemical engineering. As it can be noted the data in the table, the number of papers in the field of chemistry is 2.4 times larger than the ones in the field of chemical engineering.

Table 7. Top 10 of East European countries with papers in the field of Chemical Engineering [8] (1996-2010).

Item no.	Country	No. of papers	Citations	Hirsch index
1	Russian Federation	21077	85971	77
2	Poland	12287	85085	71
3	Hungary	3966	36878	62
4	Bulgaria	2272	25375	54
5	Czech Republic	3873	31755	53
6	Romania	5446	21992	47
7	Slovenia	1445	13576	47
8	Ukraine	4578	17731	47
9	Slovakia	1378	9838	41
10	Croatia	1546	8134	37

However, it can be seen that, for Romania, the Hirsch indices decrease following the direction shown below:

Physical chemistry > Analytical chemistry > Organic chemistry > Inorganic Chemistry
(45) (37) (35) (28)

The Hirsch index is falling

This decreasing trend is approximately the same for most of the countries.

We find out that USA's output of papers in chemistry, respectively the UK's, overtakes Romania's by 30 times in the case of the USA and 9.3 times for the UK (Fig. 1). The USA's respectively the UK's paper output in the field of chemical engineering is higher than Romania by 22.6 times (USA) and 6.1 times (UK) (Fig. 2).

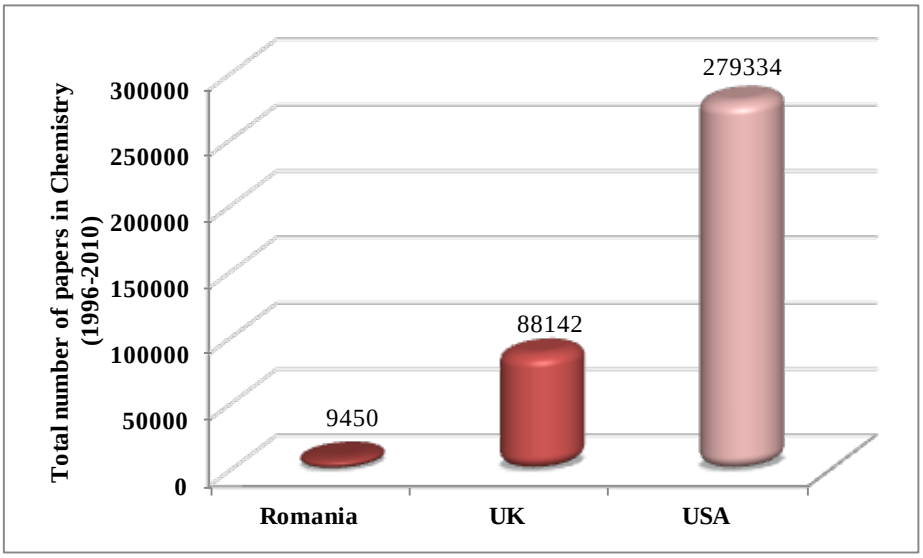

Fig. 1. Total number of papers in Chemistry published by Romania, U.K. and U. S. A over 1996-2010.

The data presented in Fig. 3 leads us to the conclusion that the productivity of the three countries in the field of chemistry is 338 papers/year for Bulgaria, 654 papers/year for Romania and 766 papers/year for Hungary, respectively.

Fig. 4 shows that productivity in the field of chemical engineering is 156 papers/year for Bulgaria, 465 paper/year for Romania and 270 papers/year for Hungary.

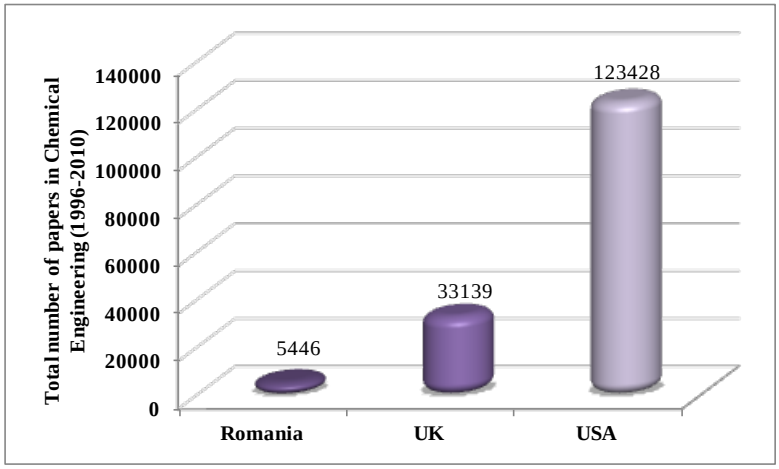

Fig. 2. Total number of papers in Chemical Engineering published by Romania, U.K. and U. S. A. over 1996-2010.

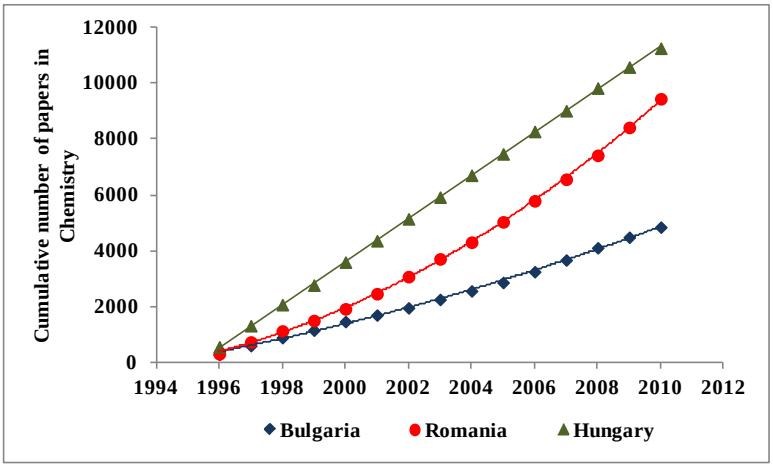

Fig. 3. Cumulative number of papers in Chemistry published between 1996-2010 by Bulgaria, Romania and Hungary.

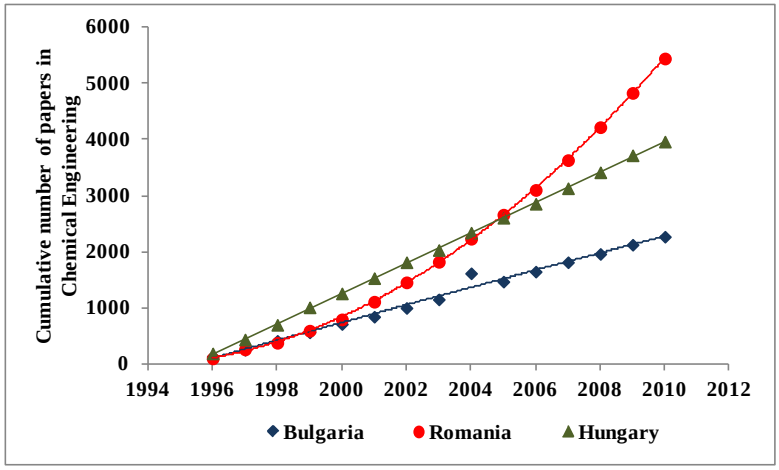

Fig. 4. Cumulative number of papers in Chemical Engineering published between 1996-2010 by Bulgaria, Romania and Hungary.

For comparison purposes, Figures 5 and 6 illustrate the productivity in the field of chemistry for U.S.A. (19,244 papers/year) and for U.K. (6,022 papers/year) and in the field of chemical engineering respectively, as follows: 8,026 papers/year (U.S.A.) and 2,152 papers/year (U.K.).

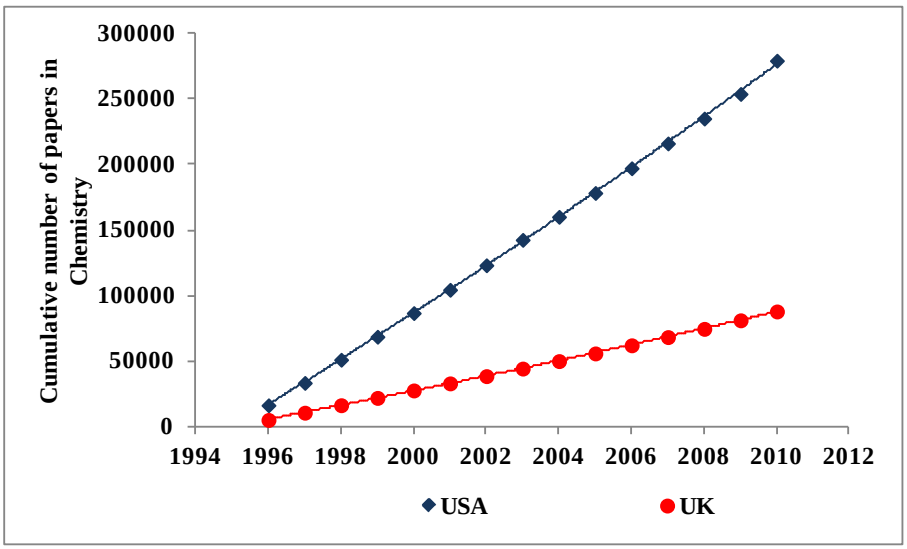

Fig. 5. Cumulative number of papers in Chemistry published between 1996-2010 by the U.S.A. and the U. K.

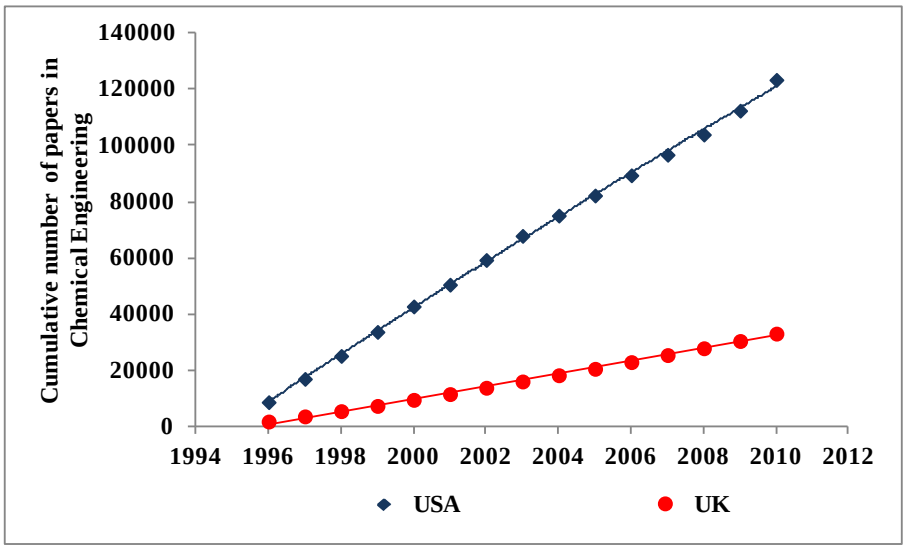

Fig. 6. Cumulative number of papers in Chemical Engineering published between 1996-2010 by the U.S.A. and the U. K.

In the end of this paper we would like to quote two valuable opinions related to the topic under discussion.

Academician Professor dr. Laurentiu Mircea Popescu stated that: “in the scientific activity there are exact indices which are put into practice by the countries in which this activity is taken into consideration very seriously”.

Academician Professor dr. Tibor Braun made the remark that: “Scientometrics was born out of necessity to know the operating mechanism of the scientific research activity, the laws and quantitative regulations which govern it in order to be able to treat it sensibly and manage it optimally…”.

4. CONCLUSIONS

The paper has attempt to provide an analysis of the rank position Romania holds as far as its scientific research performance in the field of chemistry is concerned. On the one hand, the study has focused on comparisons between our country and similar ex-communist countries from Eastern Europe. On the other hand, it has assessed Romania's position relative to Western countries to broaden the picture towards a global view on Country Rank.

We can conclude that the 1996-2010 results which have been discussed reassure us of the viability of the Hirsch –index use for the purpose of measuring and ranking the scientific performance and impact of countries in a certain field of Science, in this case, in Chemistry and Chemical Engineering. The data presented reinforces the importance of the quantitative regulations which govern the evaluation of a country's scientific research in terms of accuracy and precision.

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