Comparison of Czech and Slovak independent research in the 21st century

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Independent research of a country may be defined as research conducted solely by researchers affiliated with institutions of that specific country with no external collaborators. In fact, it represents the 'core' research a country is able to carry out without any foreign help. Therefore, studying a country's independent research may give a more genuine picture of the country's research capacities. In this study, we analyse and compare the independent research of the Czech Republic and Slovakia, two countries that emerged after the dissolution of Czechoslovakia in 1993, based on journal articles published between 2001 and 2013, and indexed in the *Science Citation Index* Expanded. We concentrate on the production of scholarly publications, research topics and journals, institutions, and citations of Czech and Slovak articles. We conclude that although Czech and Slovak independent research have some common features, they differ largely in some aspects such as article topics and citation impact.

Keywords: Scientometrics, publications, citations, topics, journals, institutions.

CZECHOSLOVAKIA split up peacefully into the Czech Republic and Slovakia in 1993. Even if similarity exists, socio-economically, both countries have gone separate ways since then and the same holds for science and research. Whereas before 1993, science performance indicators were always computed for Czechoslovakia as a whole, after its dissolution, two new entities emerged in the addresses of research paper authors and, subsequently, in the country fields of article records of bibliographic databases and citation indexes. However, the disappearance of Czechoslovakia in science was rather gradual and it only occasionally appeared in paper bylines several years after the separation due to publication and indexing delays. While there have been some studies on the performance of Czechoslovak[1,2] or Czech[3–7] and Slovak science[8], there have been no studies on the comparison of scientific performance of the Czech Republic and Slovakia, after the dissolution of the original federal republic, and no specific attempts at exploring their 'independent' research. This is the purpose of the present study.

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As is well known[9], science has become increasingly collaborative in recent decades and nowadays, a substantial number of research publications are written by authors from more than one country. However, collaborative publications may be of a different nature from non-collaborative papers due to their possible multidisciplinarity, inherent internationalization, and influence of collaborators from scientifically 'stronger' countries in the respective research area. Therefore, we believe that to understand the genuine research profile of a country, one needs to consider research publications without foreign collaborators. In our specific case, it means to examine publications written by authors from Czech institutions only for the Czech Republic, and by authors from Slovak institutions for Slovakia. By analysing the 'independent' research, we would like to answer the following research question: 'is Czech science similar to Slovak science in terms of production and impact, research areas studied, and citations of leading papers?' We will show in this study that the answer is 'negative'.

Data and methods

In October 2014, we downloaded plain text records of 45,099 Czech articles and 13,164 Slovak articles from the *Science Citation Index* Expanded (*SCI*-Expanded) database of the *Web of Science* Core Collection online application, provided by Thomson Reuters. We were interested in journal articles published from 2001 to 2013, with the 'Czech Republic' or 'Slovakia' respectively, being the single country of origin of all coauthors. No international collaboration was thus considered and even articles whose authors were jointly affiliated with an institution abroad were excluded from the analysis. Consequently, the two resulting data sets represented truly 'independent' Czech and Slovak research publications, that we further examined.

The records retrieved, included names of authors, article titles, publication years, journal names, times cited, authors' addresses and some other information, which were all imported into Microsoft Excel 2010 software. Some additional coding was then manually performed to identify the institutions of coauthors and the impact factors of the publishing journals as well as the

distributions of the words in title, author keywords, and *KeyWords Plus* in different time periods. *KeyWords Plus* provides search terms extracted from the titles of articles cited by authors in their bibliographies and footnotes in the *Web of Science* database and substantially augments title-word and author-keyword indexing[10]. In addition, the reported impact factor (IF_{2013}) of each journal was obtained from the 2013 Edition of *Journal Citation Reports*® (Thomson Reuters 2013).

Apart from 'country independent' research on the level of countries, we were also interested in the extent of 'institutionally independent' research on the level of individual institutions, where the term 'institutionally independent article' (or 'single institution article') was assigned if its authors were all affiliated with the same institution in the Czech Republic or Slovakia respectively, and the term 'inter-institutionally collaborative article' was assigned if the authors were from different institutions[11]. The extent of 'independence' of an institution may be expressed by the proportion of single institution articles in an institution's publications and leading institutions in a country are usually more independent than collaborative as we will see later in this paper. A high level of independence in a research domain may mean a more important contribution to the research conducted, whereas a low level of independence may signify supportive participation of an institution in some particular research. A similar concept is the share of 'first author' and 'corresponding author' (or 'reprint author') articles in the production of publications by an institution. A large share of these articles usually means a significant contribution to the research published because the first author is typically expected to have performed the experiments reported on and the corresponding author is quite often a senior scholar supervising the research. In a single author article where authorship is unspecified, the single author is both first and corresponding author[12]. Similarly, in a single institutional publication, the institution is classified as the first author institution as well as the corresponding author institution.

Results and discussion

As for scientific production, the 13,164 Slovak independent articles formed about 29% of Czech independent articles, which is in accordance to standard research production numbers, where Slovak counts are usually about one-third of the Czech ones, even if Slovakia's population (5.5 million) is roughly a half of the Czech population (10.5 million). About 95% of Czech articles and 96% of Slovak articles were written in English and the second most frequent language of Czech articles was Czech with 4.7%, and in 2.3% of Slovak articles, whereas Slovak was only third with 1.5% in Slovak articles and fourth (after German with 0.24%), with a share of 0.2% in Czech articles. While the Czech production of articles grew steadily from 2204 in 2001 to 4551 in 2013 (Figure 1), the Slovak research production was less robust, it started with 888 articles in 2001, nearly peaked at 1187 in 2008 and then slightly declined to eventually peak with 1194 in 2013 again. The main article features were similar in both republics between 2001 and 2013; the average number of authors per paper rose from 3.3 to 4.3 in Czech and from 3.1 to 4.0 in Slovakia, the mean number of cited references per paper grew from 22 to 33 in Czech and from 20 to 30 in Slovakia, and the average paper length ascended from 8.3 to 9.0 pages with Czech papers and from 7.6 to 8.7 with Slovak papers. As for the

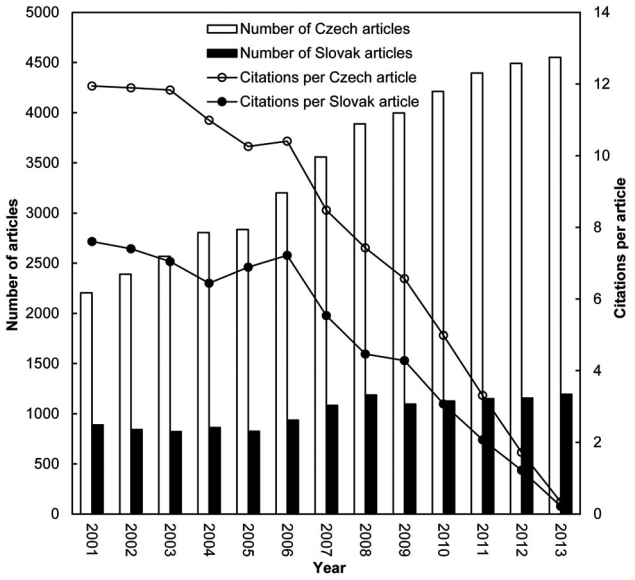

Figure 1. Czech and Slovak articles and citations.

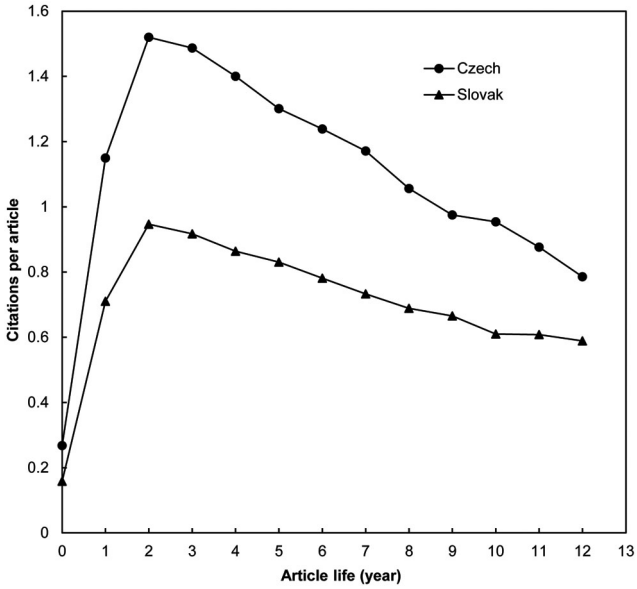

Figure 2. Citations per article by article age.

impact of articles published, older articles are cited more frequently in both countries with 11.9 citations per paper and 7.6 citations per paper in 2001 and 10.4 and 7.2 citations per paper in 2006 for Czech and Slovak articles respectively. The citation peak of articles from both countries comes after two years (Figure 2) with 1.52 citations per Czech article and 0.95 citations per Slovak article. Then the citation count per year falls down on a yearly basis after the peak, and Slovak articles exhibit a smaller citedness in general, which is on average 4.6 citations per paper, compared to 6.8 citations per paper for Czech articles.

There is also a difference in the focus of Czech and Slovak independent research that we can understand by examining Table 1 with the list of *Web of Science* subject categories to which Czech and Slovak publications are allocated and Table 2 along with Table 3 for the list of journals in which Czech and Slovak articles were published. The most abundant category for both Czech and Slovak articles is 'multidisciplinary chemistry' with a share of about 5.3% and 6.2% respectively. The other strongly represented Czech categories are 'analytical chemistry' and 'multidisciplinary materials science' approximately 5% each, with the latter being ranked third in Slovak papers, with a similar percentage. However, the second strongest research category in Slovak papers, which is not seen in Table 2, is 'biology' with a 5% share whose proportion in Czech papers (only about 1.5%) does not qualify it for the top 10 categories. Other categories with remarkably different shares in Czech and Slovak papers are 'general and internal medicine', 'multidisciplinary geosciences', and 'mining and mineral processing', which are all more strongly represented in Slovakia with 0.5% versus 2.9%, 1.6% versus 3.1%, and 0.7% versus 2.3% shares respectively, and, on the other hand, a couple of research fields more intensively studied in the Czech Republic and whose absolute shares differ largely like 'analytical chemistry' (5.1% compared to 3.2%), 'plant sciences' (3.4% to 1.8%), and particularly 'surgery' (3.2% to 1%) or those with low absolute numbers (and thus not present in Table 2) but whose relative shares are much greater in Czech research like 'imaging science and photographic technology' (13 times larger) or 'allergy' (12 times bigger). The whole rankings of the most frequent Czech and Slovak subject categories are quite highly correlated with a Spearman's rho close to 0.91 (significant at the 0.01 level two-tailed).

Table 1. Top 20 subject categories

Web of Science category	TP (%)	
	Czech	Slovakia
Multidisciplinary chemistry	2394 (5.3)	821 (6.2)
Analytical chemistry	2285 (5.1)	424 (3.2)
Multidisciplinary materials science	2224 (4.9)	652 (5.0)
Physical chemistry	2082 (4.6)	514 (3.9)
Biochemistry and molecular biology	1795 (4.0)	541 (4.1)
Neurosciences	1716 (3.8)	353 (2.7)
Plant sciences	1531 (3.4)	234 (1.8)
Surgery	1421 (3.2)	125 (1.0)
Applied mathematics	1368 (3.0)	343 (2.6)
Mathematics	1357 (3.0)	468 (3.6)
Food science and technology	1291 (2.9)	392 (3.0)
Applied physics	1272 (2.8)	476 (3.6)
Electrical and electronic engineering	1251 (2.8)	454 (3.5)
Environmental sciences	1216 (2.7)	361 (2.7)
Veterinary sciences	1215 (2.7)	441 (3.4)
Organic chemistry	1096 (2.4)	222 (1.7)
Condensed matter physics	1089 (2.4)	444 (3.4)
Oncology	1070 (2.4)	262 (2.0)
Multidisciplinary physics	1009 (2.2)	422 (3.2)
Biochemical research methods	974 (2.2)	159 (1.2)

TP, total number of country independent articles.

The above results are further corroborated by the journals in which Czech and Slovak articles are published most frequently and which are shown in Tables 2 and 3. The Czech focus on surgery is demonstrated on the high number of publications in the Czech journal *Ceska A Slovenska Neurologie A Neurochirurgie* and the Slovak concentration on biology is documented by frequent publications in the Slovak journal *Biologia*. This top journal also has a more dominant position with a 4.1% share of publications than the top journal for Czech publications (*Chemicke Listy*), which has a roughly equal publication share (1.9%) as the second most popular journal. In this context, it is interesting to note that even if 'multidisciplinary chemistry' belongs to the most studied categories in both countries, researchers in this field tend to publish their results in their respective national, or domestic, journals, namely *Chemicke Listy* in the Czech Republic and *Chemical Papers* in Slovakia. Also, there is only one foreign journal among the top publication outlets for Czech articles – the Swedish journal *Neuroendocrinology Letters* – and three foreign journals (all from Czech) among the top journals for Slovak articles – *Chemicke Listy*, *Folia Microbiologica*, and *Acta Veterinaria Brno*. Independent research in both countries is thus heavily published in domestic outlets.

To further study into the contents of Czech and Slovak articles, we also analysed the occurrences of words in article titles, author keywords, and *KeyWords Plus* and we briefly present the most interesting results. Czech and Slovak articles have many title words in common and the most frequent words are: 'Czech', 'effect', 'republic', 'patients', 'properties' and 'effect', 'properties', 'Slovakia', 'influence', and 'model' respectively. 'Czech' and 'plasma' are the most frequent Czech title words that do not appear within the 50 most frequent Slovak title words with some of the others being 'case', 'distribution', 'protein', 'films', 'disease', and 'molecular'. By contrast, frequent Slovak title words that are 'infrequent' in Czech article titles are 'Slovakia', 'Slovak', 'rat', 'selected', 'parameters', and 'stress'. A total of 39 words are common in the top 50 and the similarity between the 50 most

Table 2. Top 10 journals in which Czech articles were published

Journal	TP (%)	IF_{2013}	*Web of Science* category
Chemicke Listy	860 (1.9)	0.196	Multidisciplinary chemistry
Ceska A Slovenska Neurologie A Neurochirurgie	767 (1.7)	0.159	Neurosciences; surgery
Physiological Research	582 (1.3)	1.487	Physiology
Acta Veterinaria Brno	511 (1.1)	0.448	Veterinary sciences
Collection of Czechoslovak Chemical Communications	422 (0.94)	1.137	Multidisciplinary chemistry
Neuroendocrinology Letters	399 (0.88)	0.935	Endocrinology and metabolism; neurosciences
Czech Journal of Animal Science	390 (0.86)	0.871	Agriculture, dairy and animal science
Listy Cukrovarnicke A Reparske	381 (0.84)	0.273	Food science and technology
Radioengineering	377 (0.84)	0.796	Electrical and electronic engineering
Czechoslovak Journal of Physics	353 (0.78)	N/A	Multidisciplinary physics

TP, Number of articles; IF_{2013}, Impact Factor by 2013 Edition of *Journal Citation Reports* ® (Thomson Reuters, 2014); N/A and Not available.

Table 3. Top 10 journals in which Slovak articles were published

Journal	TP (%)	IF_{2013}	*Web of Science* category
Biologia	538 (4.1)	0.696	Biology
Bratislava Medical Journal-Bratislavske Lekarske Listy	340 (2.6)	0.446	General and internal medicine
Acta Montanistica Slovaca	270 (2.1)	0.053	Multidisciplinary geosciences; mining and mineral processing
Chemical Papers	268 (2.0)	1.193	Multidisciplinary chemistry
Ekologia-Bratislava	208 (1.6)	N/A	Ecology
Chemicke Listy	206 (1.6)	0.196	Multidisciplinary chemistry
Neoplasma	177 (1.3)	1.642	Oncology
Folia Microbiologica	156 (1.2)	1.145	Biotechnology and applied microbiology; microbiology
General Physiology and Biophysics	149 (1.1)	0.875	Biochemistry and molecular biology; biophysics; physiology
Acta Veterinaria Brno	139 (1.1)	0.448	Veterinary sciences

TP, Number of articles; IF_{2013}, Impact Factor by 2013 Edition of *Journal Citation Reports* ® (Thomson Reuters, 2014).

frequent Czech title words and the 50 most frequent Slovak title words is 0.51 using the shortest edit script algorithm by Myers[13], where 1 means that 2 strings are identical and 0 means that they are entirely different. On the other hand, the similarity between the top Czech author keywords and the top Slovak author keywords is only 0.45 with far less keywords (19 out of 50) belonging to both sets such as 'apoptosis', 'rat', 'mechanical properties', 'HPLC', 'PCR', 'morphology', 'heavy metals', 'taxonomy', or 'oxidative stress'. The exclusive Czech top author keywords include 'Czech Republic', 'new species', 'Coleoptera', 'X-ray diffraction', 'pig', 'polymorphism', and 'mass spectrometry' to name a few and the Slovak ones include 'Slovakia', 'kinetics', 'western Carpathians', 'rabbit', 'hypertension', 'antioxidants', and 'effect algebra' among others. And finally, the similarity between the top Czech *KeyWords Plus* and the top Slovak *KeyWords Plus* is only slightly higher with 0.5 although there are quite many common keywords (38 out of 50), which are, however, ranked differently by occurrence. Some of them are 'expression' and 'growth' (which are the top keywords in both article sets), 'model', 'behavior', 'identification', and 'in-vitro'. The top exclusive Czech *KeyWords plus* include 'complexes', 'performance liquid-chromatography', and 'spectroscopy' and the top exclusive Slovak ones involve 'oxidative stress', 'mechanisms', and 'escherichia-coli'. We may conclude that as far as article title words, author keywords, and *KeyWords Plus* are concerned, the topics of Czech and Slovak independent articles are rather different with regard to their priority and more similar if only the overlay of their keywords is taken into account.

In Tables 4 and 5 we can see the top Czech and Slovak institutions that produced the most articles in the period under study. Whereas there are 12 Czech institutions that published at least 1000 papers each, there are only 7 Slovak institutions that produced at least 250 publications each. Even if the population of Slovakia is about a half of the population in the Czech Republic (5.5 million compared to 10.5 million inhabitants), which can explain the lower Slovak research production, the numbers we present in this study document a substantially smaller scientific productivity of Slovakia in independent research. Whereas the Slovak Academy of Sciences dominates Slovak institutions with a 38% share of Slovakia's independent research publications, comfortably ahead of the second is Comenius University with 23%, there are two leading institutions in the Czech Republic's independent research, namely the Academy of Sciences of the Czech Republic and the Charles University in Prague with 31% and 26% publication shares respectively. The third ranked Slovak institution, Slovak University of Technology with 2132 publications, would only be ranked seventh within the top 12 Czech institutions,

Table 4. Czech top 12 institutions with TP > 1000

Institution	TP	TPR (%)	IP (%)	CP (%)	FP (%)	RP (%)
Acad. Sci. Czech Republic	14,195	1 (31)	5761 (41)	8434 (59)	10,037 (71)	10,021 (71)
Charles Univ. Prague	11,521	2 (26)	4167 (36)	7354 (64)	7480 (65)	7407 (64)
Masaryk Univ.	3905	3 (8.7)	1466 (38)	2439 (62)	2501 (64)	2485 (64)
Inst. Chem. Technol.	2992	4 (6.6)	1179 (39)	1813 (61)	1961 (66)	1931 (65)
Czech Tech. Univ.	2766	5 (6.1)	1531 (55)	1235 (45)	2025 (73)	2011 (73)
Palacky Univ.	2520	6 (5.6)	1087 (43)	1433 (57)	1815 (72)	1823 (72)
Univ. S. Bohemia	1740	7 (3.9)	336 (19)	1404 (81)	830 (48)	821 (47)
Brno. Univ. Technol.	1701	8 (3.8)	987 (58)	714 (42)	1246 (73)	1244 (73)
Czech. Univ. Life Sci. Prague	1539	9 (3.4)	657 (43)	882 (57)	1119 (73)	1118 (73)
Univ. Pardubice	1469	10 (3.3)	729 (50)	740 (50)	1143 (78)	1139 (78)
Univ. Vet. & Pharmaceut. Sci.	1272	11 (2.8)	426 (33)	846 (67)	829 (65)	823 (65)
Mendel Univ. Brno.	1191	12 (2.6)	453 (38)	738 (62)	816 (69)	810 (68)

TP, Number of articles; IP, Institutionally independent articles; CP, Inter-institutionally collaborative articles; FP, First author articles; RP, Corresponding author articles and R, rank.

Table 5. Slovak top seven institutions with TP > 250

Institution	TP	TPR (%)	IP (%)	CP (%)	FP (%)	RP (%)
Slovak Acad. Sci.	5011	1 (38)	2835 (57)	2176 (43)	4100 (82)	3910 (78)
Comenius Univ.	3034	2 (23)	1518 (50)	1516 (50)	2260 (74)	2247 (74)
Slovak Univ. Technol. Bratislava	2132	3 (16)	1294 (61)	838 (39)	1712 (80)	1704 (80)
Safarik Univ.	1096	4 (8.3)	467 (43)	629 (57)	818 (75)	749 (68)
Tech. Univ. Kosice	712	5 (5.4)	426 (60)	286 (40)	608 (85)	494 (69)
Univ. Vet. Med.	514	6 (3.9)	153 (30)	361 (70)	363 (71)	254 (49)
Slovak Univ. Agr.	298	7 (2.3)	112 (38)	186 (62)	217 (73)	165 (55)

TP, Number of articles; IP, Institutionally independent articles; CP, Inter-institutionally collaborative articles; FP, First author articles; RP, Corresponding author articles and R, rank.

which illustrates the weakness of Slovak independent research again. The different roles played by the two national Academies in their respective countries are also demonstrated by the other indicators like the share of publications produced by a single institution (independent papers – IP), several institutions (collaborative papers – CP), or the share of first author (FP) and corresponding author (RP) articles. For example, the single institution articles of the Czech Academy of Sciences form 41% of all of its articles compared to 59% of its articles that are collaborative, i.e. published together with co-authors from other Czech institutions. Similarly, 71% of its articles are first author papers and the same proportion applies to corresponding author papers. Thus, over 70% of its publications are produced with a significant contribution of the Czech Academy of Sciences, exceeding a 'simple' co-authorship participation. By contrast, the Slovak Academy is more dominant in single institution papers (57%) and less relying on collaborative papers (43%). Also its share of first author and corresponding author papers is slightly higher (82% and 78%) compared to its Czech counterpart and very high in absolute terms. Again, this demonstrates the outstanding status of the Slovak Academy of Sciences in Slovak independent research. Let us note in this place that it is difficult to disambiguate and unify institutional names precisely hence figures in this section must be considered approximate.

We are interested in all these indicators because they all describe different aspects of research productivity. The number of single institutions and collaborative articles tell us about the research independence of a specific institution. For instance, the Czech Academy of Sciences published 31% of Czech publications and 59% of its papers are collaborative. This means that the Czech Academy publishes less frequently alone, but is often used as a collaborative partner of other Czech institutions. The same holds true for the Charles University in Prague and for other universities as well, with the extreme case being the University of South Bohemia with only 19% of single institution papers and thus heavily dependent on other institutions to publish research. In fact, the only top Czech institutions that are more independent than collaborative are the Czech Technical University in Prague (ranked fifth) with 55% of its publications being single institution articles and Brno University of Technology (ranked eighth) with 58% of independent articles. Interestingly, the University of Pardubice (rank 10) has the independence/collaboration ratio quite well balanced (both 50%). The situation is different with the Slovak top institutions in that there are three 'independent' institutions (Slovak Academy of Sciences, Slovak University of Technology, and Technical University of Kosice) and three 'collaborative' institutions Safarik University, University of Veterinary Medicine, and Slovak University of Agriculture, and one

Table 6. Czech top 10 cited articles

Rank (TC_{2013})	Rank (C_{2013})	Rank (C_0)	Rank (TCPY)	Paper
1 (717)	1 (126)	70 (6)	1 (90)	Jurecka *et al.*[14]
2 (388)	139 (15)	1 (27)	4 (35)	Widimsky *et al.*[15]
3 (332)	3 (58)	931 (2)	9 (28)	Tichy[20]
4 (286)	30 (27)	931 (2)	20 (22)	Meluzin *et al.*[21]
5 (262)	913 (7)	212 (4)	24 (20)	Palecek and Fojta[22]
6 (261)	30 (27)	7806 (0)	20 (22)	Hobza and Sponer[23]
7 (260)	8 (48)	7806 (0)	3 (37)	Slaby *et al.*[24]
8 (248)	36 (26)	7806 (0)	18 (23)	Jurecka and Hobza[25]
9 (226)	17 (33)	212 (4)	9 (28)	Petrek *et al.*[26]
10 (224)	26 (28)	11 (10)	12 (25)	Dolezel and Bartos[27]

TC_{2013}, Total citations counted since articles were published until the end of 2013; C_{2013}, Number of citations in 2013; C_0, Number of citations in publication year and TCPY, TC_{2013} per year.

Table 7. Slovak top 10 cited articles

Rank (TC_{2013})	Rank (C_{2013})	Rank (C_0)	Rank (TCPY)	Paper
1 (242)	2 (37)	1517 (0)	2 (19)	Madejova and Komadel[16]
2 (230)	1 (40)	1517 (0)	3 (18)	Kuzmik[17]
3 (141)	3 (29)	387 (1)	1 (20)	Kucerova *et al.*[19]
4 (126)	418 (4)	1517 (0)	6 (11)	Kotrusz *et al.*[28]
5 (118)	128 (7)	387 (1)	6 (11)	Lukac[29]
6 (102)	173 (6)	387 (1)	22 (8.5)	Dvurecenskij[30]
6 (102)	24 (14)	1517 (0)	4 (15)	Cikos *et al.*[31]
8 (100)	31 (12)	1517 (0)	14 (9.1)	Švastová *et al.*[32]
9 (99)	173 (6)	1517 (0)	28 (8.3)	Simko[33]
10 (94)	699 (3)	387 (1)	45 (7.2)	Duncko *et al.*[34]

TC_{2013}, Total citations counted since articles were published until the end of 2013; C_{2013}, Number of citations in 2013; C_0, Number of citations in publication year and TCPY, TC_{2013} per year.

'neutral' university Comenius University, in terms of their proportion of independent versus collaborative articles. On the other hand, the numbers of first author and corresponding (or reprint) author articles indicate the strong connection between an institution and the articles it publishes because the participation of that institution's researchers in some research is generally considered higher if one of its researchers is the first or corresponding author of a research paper. In this context, it is interesting to note that the University of Pardubice has the largest share of first author papers (78%), indicating its major contribution even in collaborative articles. On the other hand, the University of South Bohemia has the smallest percentage of first author papers (48%), which further corroborates its strong dependence on other institutions. By contrast, all the Slovak institutions show high shares of first author papers ranging from 71% for the University of Veterinary Medicine (but with a remarkably low percentage of corresponding author papers of just 49%) to 85% from the Technical University of Kosice. In general, the share of corresponding author papers differs from that of the first author papers to a greater extent (usually smaller) than in Czech institutions and may signify a different approach while assigning correspondence in Slovakia than in Czech universities where the first author is quite often the corresponding author at the same time.

Another sort of comparison of Czech and Slovak independent research is possible by looking at the most influential (in terms of citations) articles shown in Tables 6 and 7. The top 10 articles are sorted by the number of times they were cited until the end of 2013 in descending order and their citation counts in 2013 alone, in their publication year, and citations per year along with the respective ranks are also shown. The most cited Czech article is Jurecka *et al.*[14] with 717 citations received in total and which is the most highly cited article continuously since 2007, comfortably ahead of Widimsky *et al.*[15] with 388 citations, which peaked with 58 annual citations in 2005. In Slovakia the position of the most cited article is less dominant: it is Madejova and Komadel[16] neatly ahead of Kuzmik[17], which, on the other hand, has regularly had more annual citations since 2009. The Czech number one paper was also the most frequently cited article in 2013 with 126 citations and the best article in terms of citations per year (90). However, in the year of its publication (2006) it was rarely cited (6 citations). On the other hand, the Czech number two paper was cited 27 times in the year of publication (2003), which secured it the first place in the respective ranking, but its citation count in 2013 is low and its rank is occupied by Haring and Kypr[18] with 76 citations in 2013, which is not shown in Table 7 because its total times cited (203) does not fall within the top 10 articles.

The Slovak top two articles exchanged their positions in ranking by citations in 2013, but none of them was cited at all in 2001 when they were published. In addition, there were both overshadowed by Kucerova *et al.*[19] with 20 citations per year in the ranking by average yearly citations. There are three subject categories to which more than one top Czech paper is allocated: 'Cardiac and Cardiovascular Systems', 'Multidisciplinary Chemistry', and 'Plant Sciences' with two articles each. In Slovakia there is only one such category with two or more articles, 'Oncology', and the journals in which the top Slovak articles appear are usually ranked lower by Impact Factor in their respective categories.

Conclusions

Independent research of a country may be defined as research conducted completely within that country without any help of foreign collaborators. It usually results in scientific publications written by authors affiliated with institutions from that country and no other. Therefore, we may regard independent research as 'core' research carried out in a country with no external influence. As a consequence, research results achieved by mainly foreign scholars with minor contribution of scientists from the country under study are filtered out and only those produced solely by the country's own resources are taken into account. We believe that a country's research profile based on independent research may differ substantially from a standard research profile and may reflect a country's research capacity more genuinely, especially when small and open countries are concerned. In this study we analysed independent research in the Czech Republic and Slovakia, two countries that emerged after the dissolution of Czechoslovakia in 1993, and made the following main contributions:

- We examined all journal articles published independently by the Czech Republic and Slovakia between 2001 and 2013 that were indexed in the *Science Citation Index* Expanded.
- We analysed the independent research production of both countries in terms of research topics, publication outlets, and prolific institutions.
- We compared the impact of independent research of the Czech Republic and Slovakia in terms of the most cited articles of both countries.

The key results of our study are as follows:

- The two countries differ substantially from each other in terms of productivity, research topics as well as impact of their independent research.
- Slovakia's production was only 29% of the Czech production, which included 45,099 articles, and both countries relied almost equally heavily on 'multidisciplinary chemistry' and 'multidisciplinary materials science' as well as on many other research fields, but as for the differences, Slovakia concentrated more on 'biology' and 'general and internal medicine' while Czech publications preferred 'analytical chemistry', 'plant sciences' and 'surgery' by contrast.
- Czech independent research is more frequently cited than Slovak independent research with 6.8 citations per paper compared to 4.6 and so are the most highly cited articles in both countries with 717 total citations of the top Czech paper and 242 total citations of the top Slovak paper.

Scientometric studies of independent research of countries make sense in particular for small and open economies that are less self-contained and that usually collaborate extensively with foreign countries in their research projects. This may now well apply to the former Eastern block countries and we will thus concentrate on the comparison of their independent research in our future studies.

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