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Productivity and its impact in the ISI and Scopus citation databases from 1996 to 2005

1. Introduction: problem, previous research, theoretical and hypothetical starting points

The need to empirically investigate and describe the specificities of scientific communication, bibliometrically defined by published papers and citation analyses in individual fields and disciplines, usually arises from the competitive relations and limited financial resources of scientific research. The results of such studies underpin the theoretical basis of scientific communication and generate insights into the development of science and individual scientific disciplines. Indeed, they are one of the segments of the sociology of science, that is, the science of science.

In almost all countries, the system of evaluation of scientific work is based on bibliometric analyses, peer reviews, or a combination of the two approaches. Until recently, the citation databases of the Institute for Scientific Information, Philadelphia, USA(ISI), the Science Citation Index (SCI), the Social Science Citation Index (SSCI), and the statistics database Journal Citation Reports (JCR) were the basic instruments of bibliometric studies. With the establishment of the Scopus (Elsevier)[1] citation database late in 2004, the system of the evaluation of scientific output gained a new dimension. The development of Google Scholar[2] will also certainly have an influence on the evaluation system in sciences.

The organisational concept of the ISI citation databases, SCI, SSCI, A&HCI (Arts&Humanities Citation Index), known today under the commercial name WoS (Web of Science), and that of Scopus differ fundamentally. While the idea of the selection and inclusion of journals in the ISI citation databases is based on Bradford's law of scattering,

[1] http://info.scopus.com/overview/what/ (retrieved on July 9, 2007).
[2] http://scholar.google.com/intl/en/scholar/about.html (retrieved on July 9, 2007).

Scopus has a much broader definition of inclusion of primary sources of information. Even though Google Scholar will not be included in this research, we believe it deserves mention as a new system in evaluating scientific work. Google Scholar has a much greater range of sources of scientific literature than Scopus and a greater capacity for monitoring their citation rates, and it is intended to eventually cover all more or less relevant electronically available sources of information from around the world. This provides the global scientific community with the opportunity to evaluate the relevant sources itself, without any restrictions, conditionally speaking, instead of letting commercial secondary sources make the selection. Since the topic of this paper is to empirically investigate scientific productivity and its impact, the issue hinted at here is too broad to be considered in greater detail in this paper.

Let us first explain Bradford's Law in order to more easily understand the differences between the ISI and Scopus citation databases. Bradford's Distribution, the Law of Scatter, or the Law of Scattering of fields in journals, states that the greatest number of articles discussing a certain problem is found in a smaller number of journals, or, in other words, that the greatest number of journals cover these problems in one or two articles (Bradford, 1934). The most productive journals in a given field are called the "core", which consists of a relatively small number of journals with the greatest number of articles on a certain problem. Depending on the field, there are two or more zones of journals that include proportionally fewer articles on a certain topic, but in a greater corpus of journals. Such distribution can be defined in the approximate ratios $1 : n : n^2$ ...

For precisely this reason, ISI's citation databases have been covering less than 10% of global scientific production in all fields since they were established in the 1960s, thus generating the so-called "core" of the world's knowledge. In practice, SCI was covering around 600 journals in the field of the natural and applied sciences in the 1960s, and today, the number comes to around 7,000! The citation database WoS, consisting of all three citation databases (SCI, SSCI and A&HCI), covers around 9,000 journals from across the world today. Since the number of journals has increased just over ten times on the global level, the percentages remain the same.

For almost every scientist in the world, being part of the so-called *core of the world's knowledge* is a formal acknowledgment of the scientist's value and is part of the existing global evaluation system. In a smaller scientific community, such as Croatian, where, in addition, English is not the mother tongue but a *lingua franca*, inclusion in the core of the world's knowledge is certainly an important indicator of the evaluation of its scientific work.

Furthermore, the inclusion of papers in ISI citation databases certainly implies that the papers were subject to international review procedures, which differ in strictness, but require that the formal conditions of the journals be met and that the paper be eligible both in terms of the topic and content. Being listed in the most selective databases may offer scientists the opportunity to become more visible to the overall scientific community. Their papers' citation count, still one of the fundamental indicators of assessing the impact of a scientist's work, can reveal how interesting and useful their work is to the global scientific community.

New technological achievements offer new ways of measuring the extent to which a paper is read, browsed or saved, which is certainly an indicator of the potential impact of the paper. One of the more recent proposals of methodology for evaluating scientific work was presented and implemented by Chen et al. (2007). They introduced the PageRank Google algorithm which covers the network of citations of a certain journal or scientist, and ranks a certain paper based on the number of citations and type of sources citing it.

The originators of Scopus were led by an idea to select journals into their database that was somewhat different from that of ISI. Scopus, like WoS, is a multidisciplinary bibliographic and citation database processing the content of over 15,000 journals, more than 750 collections of papers presented at conferences, patents and other sources of information[3] from across the world. It seems that the idea of this bibliographic and citation database is to offer scientists relevant, scientifically and professionally selective, multidisciplinary sources on a significantly broader platform than ISI's. There is reason to assume that this approach to the organisation of the citation database came from the relatively large discontent of European scientists, primarily those from the Nordic countries, France and Germany, with the ISI/Thomson's selection of journals covered by WoS, that is, its selection policy. To be more precise, the excessive domination of Anglo-American journals, especially in some fields (Carpenter and Narin, 1981; Sivertsen, 1993),

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[3] http://info.scopus.com/overview/what/ (retrieved on 25 September 2007)

and not only in the social sciences and humanities, but even biomedicine, is considered one of the key deficiencies of WoS. This problem also certainly affects citations and the principle of the general accessibility of scientific information.

In order to obtain as comprehensive a picture of the publishing productivity of Croatian social and natural scientists as possible, we used the capacities of both citation sources. We assumed that there was a difference between individual fields of science, or the social and natural sciences respectively, in the number of published papers and citations, simply due to the different concepts of the selection of sources of information in WoS and Scopus. Since Scopus covered over 60 Croatian journals from all scientific fields, and WoS indexed 13 Croatian journals in the same period from 1996 to 2005, it is logical to expect that the number of papers will show significant differences in some scientific fields.

Whether a paper was published in a local or international journal is a relevant factor for an assessment of the paper, just like the status of the journal within a discipline. It is not at all the same to publish a paper in an international journal with an established and clearly defined review procedure, which also usually includes two competent reviewers (alongside the editor), and in a national journal in the mother tongue with perhaps one review. The scientific field makes a difference as well. A paper in the field of the humanities or dealing with a specific problem in the social sciences could be of much greater importance for the local scientific audience which it targets if it is published in a national journal than if it is published in a WoS journal which does not attract any significant interest at the international level.

However, this claim would hardly hold water for the majority of works in the field of the natural science. For this reason, one should be quite careful when assessing scientific productivity in the natural and social sciences respectively. Moed (2005) points out that the social sciences and humanities, unlike the natural sciences, do not have a well-defined methodology for evaluating scientific activity. The adoption of the evaluation system of the natural sciences, and its "mechanical" application to the social sciences and especially to the humanities, is hardly justifiable in theory. It is extremely important to bear in mind the specificities of a particular field, such as scientific communication, publishing habits (preference of monographs, domestic or foreign journals), as well as the citation system. The social sciences are a rather heterogeneous group of disciplines. Psychology, psychiatry and fields closer to biomedicine (classified as social sciences by ISI in all of its classifications), but also economics, are closer to the natural sciences in terms of methodology, and citation database analyses are to a certain extent suitable for them. Moed claims that sociology, political science and anthropology tend more towards the humanities, that the book is a crucial communication medium, and that the so-called national publication model is much more relevant for them than the citation databases.

For some social science fields, such as law or some disciplines of political science or geography as a field of natural science, national sources are considered the key communication channel since they deal with the specific problems that are of greatest concern to the local scientific and professional community. However, as far as a more extensive study or development of an idea that could interest the wider scientific community is concerned, it is important to publish in prestigious international journals, thus contributing to the development of the discipline, but also to the recognisability of the author, or the institution and the country.

The impact of a certain scientific paper is at the time mostly measured by the citation count and analysis. Citation analyses include differentiation between different types of citations, self-citation and independent citations, clusters, qualitative citation analyses, analyses of journals and authors cited, the context in which the paper is cited, positive or negative citation, etc.

Measuring the number of citations that a certain paper earns requires great caution. Not only different disciplines, but also individual branches and narrow fields within one discipline cannot be compared without additional indicators and explanations. It is especially dangerous to compare the scientific productivity of the natural and social sciences uncritically. The methodology of some fields of the social sciences, such as psychology, information science, kinesiology, and economics is closer to that of the natural sciences, so citation databases are much more applicable to them than to legal science or some disciplines of political science.

Apart from the number of published works, the number of citations earned, and the average number of citations per paper, in this study we applied for the first time in Croatia a relatively new bibliometric indicator, the *h*-index. The physicist J. E. Hirsch (2005), aware of the weaknesses of the existing indicators of scientific productivity, the number of papers published, and their impact, measured by the total number of citations, the average number of citations per paper, and the number of papers with an above-average number of citations, attempted to introduce an indicator that could be used to measure the wider impact and recognisable influence of the work of an individual scientist – the *h*-index.[4] A scientist has an *h*-index of *h* if he or she has *h* publications that are cited at least *h* times. In practice, if an author published 10 papers over a certain period, and if each of those ten papers was cited at least ten times, the author's *h*-index will be 10. Batista et al. (2006) purport that the *h*-index has several advantages: it combines productivity with impact and it is not sensitive to extreme values in the sense of papers without citation or with few citations, as well as to papers with an above-average number of citations. It also directly indicates the most relevant papers in terms of citations obtained. However, the *h*-index is sensitive to the comparison of fields, even within one discipline, for example of theoretical physics and high energy physics (Egghe, 2007). Batista et al. and van Raan (2006) warn that it is important to investigate the effect of the number of authors on the total number of citations in the interpretation of the *h*-index. They proved that the higher the number of authors, the greater the number of self-citations, which can directly boost the *h*-index unless self-citations are excluded.

In practice, the exclusion of self-citation, an option inherent in both Scopus and WoS, is still not reliable. Furthermore, it is important to define the precise scope of the term self-citation. The manual search and extraction of self-citations requires a great amount of time, and it is very difficult to conduct on a greater sample of authors.

Batisa et al. assume that the frequency of publication and delays in publishing also affect the *h*-index, and Van Raan points out that the type of article also affects the *h*-index. It has been proven that review papers are cited much more frequently than original scientific work. The scientist's age is also relevant. Apart from the most widely used bibliometric indicators for evaluating scientific activity, the *h*-index is (apart from the above) also an important indicator for the interpretation of an individual scientific field or discipline.

[4] The *h*-index was developed by Jorge Hirsch, a physicist from the University of California in San Diego in 2005. Hirsch's goal was to qualify the impact and quantity of scientists' individual production. http://info.scopus.com/june_07/#2 (retrieved on 6 July 2007)

With this study, we wanted to gain insight into the scientific productivity of doctors of science in the fields of the social and natural sciences, and the impact of those papers, as measured by their citation count. Furthermore, we expect the results to indicate the extent to which the applied bibliometric indicators are actually appropriate for individual scientific fields. We decided to compare Scopus and WoS starting from the hypothesis that Scopus is the more appropriate database as a relevant source of information for works created in Croatia, especially those in the field of the social sciences. We also started from the hypothesis that Scopus was more suitable to evaluate papers from some natural science fields, such as geography and geology, which are classified as so-called national sciences in Croatia.

2. Methodology

The starting point of our study was the identification of the population of doctors of the natural and social sciences. To be more precise, the study covered all Croatian scientists holding a doctoral degree in the natural or social sciences and employed in registered scientific institutions[5] in Croatia. The data were obtained from the Ministry of Science, Education and Sports of the Republic of Croatia, reporting the situation in June 2004.

In total, 1,938 Croatian scientists, doctors of science, were identified and classified in 9 fields of the social sciences: psychology, pedagogy, legal science, economics, political science, sociology, special education, kinesiology, and information science, and 6 fields of natural sciences: mathematics, chemistry, physics, biology, geography, and geology.

We embarked on an investigation into scientific output and its impact as measured by the number of citations earned by searching the WoS (SCI Expanded and SSCI) ISI/Thomson citation database, and the Scopus citation database (Elsevier) for the period from 1996 to 2005. Both databases are available to the Croatian academic community in the internet version at the following URL addresses: http://portal.isiknowledge.com/portal.cgi and http://www.scopus.com/scopus/home.url.

Since the time span is an important indicator in our study, it is necessary to stress that the database search by year may include a

[5] Doctors of science who were not employed in registered scientific institutions, but, for example, in companies whose core activity was not science and research, were not included in the list of scientists and researchers delivered by the Ministry.

smaller number of papers from the previous year. For example, journals published near the end of 1995 and processed in WoS in 1996 will be reported as papers published in 1996 in the search. There is also the possibility, but a much smaller one, that 2006 is covered in 2005 because some journals, especially those with more intensive publication dynamics, might be published ahead of time.

Since we had a familiar population of scientists, the most reliable way of obtaining accurate data was to search by surname and forename, or by the initials of each of the 1,938 researchers. The main reason for this approach of collecting data is based on the fact that there are a greater number of scientists with the same forename and surname. It happened also that sometimes even up to 5 scientists from our sample had the same forename and surname, and were engaged in completely different fields. In order to obtain relevant data, each scientist had to be matched to their own paper. A useful tool in the WoS database is the option to link an author with the field or fields they are active in. The option is currently of far greater quality in WoS than in Scopus. We assume that it is because ISI has a more sophisticated classification of scientific fields and the fields relate to the journals indexed by WoS and are statistically processed in its JCR (Journal Citation Reports) database. Since Scopus does not have such tools at hand, and for other reasons, it is not reliable to use the option of the field as an additional indicator to determine authorship more easily.

The problem we encountered while looking into the scientific activity of female scientists is their inconsistent use of two surnames, that is, the use of different variants of the surname. To illustrate, we report possible variants: Jurić-Perić, A.; Perić-Jurić A.; Perić, A.; Jurić, A. Unless we are aware of this fact, the possibility of making mistakes is not insignificant.

The mistakes that were more noticeable in Scopus than in WoS were wrongly assigned addresses of authors, which required additional research. The same goes for linking individual authors with their classification of the fields. A paper was often classified in several different fields, which did not correspond to the actual situation. Another specific problem was the female scientists who had two surnames, and WoS and Scopus would register them under their forename, and both surnames would be given as initials. We solved this problem by using our own long experience in database search and our knowledge of the authors.

Thus, the collected data are based on an analysis of papers and their citations for each scientist, that is, for each individual author. In our case, we made a distinction between scientists and authors, because some scientists from this population did not publish any works. Each author, regardless of his position in a co-authored paper, was assigned equal authorship. In practice, if a paper was authored by two or more scientists, and they were all a part of our sample, the paper was ascribed to each of the authors as theirs.

The software used at the time of the search did not offer a reliable option of selecting types of works included in the analysis. For that reason, we used all types of works and contributions in searching the number of registered works by one individual author in WoS and Scopus. In practice, this means that, apart from articles, that is, original scientific articles, the analysis also included meeting abstracts and letters. The difference that the exclusion of all other publications except articles from our analysis would make to the findings on the scientific activity of scientists from our sample could only be researched later. However, looking into the categorisation of articles in WoS and Scopus, based on our own experience, we determined that there was no consensus. Professional papers and even reviews were often classified as articles or scientific papers.

The data on the number of citations refer exclusively to papers published by the authors from our sample in the period from 1996 to 2005. It is extremely important to point out that we took the number of citations both from WoS and Scopus based on their options of automatically ascribing citations and the number of citations to a specific paper. However, we did not analyse mistakes in the process, such as whether the forename and surname, journal or bibliographic data connected to the paper were written correctly.

Due to the limited time, we did not embark on citation analyses at the level of separating self-citation from independent citation in this study. Although both databases offered the option to exclude self-citation from the search, we did not use the option because we tested the option and determined that the results were unreliable. This remark refers to Scopus in particular.

It is very important to say that the search was conducted in the course of one week, in July 2007, because WoS and Scopus are updated once a week, usually at the beginning of the week. In practice, this means that the data in the databases remained unchanged during that week. If we had extended the search to two or more weeks, the data on the number of citations would no longer be the same, and the *h*-index value might also be different.

We took the values of the *h*-index for each individual author directly from both databases. Both WoS and Scopus offer the automatic option of using the *h*-index, which made our work much easier. However, even though we said that self-citations were not excluded from the citation count, it should be noted that self-citations were not excluded in the *h*-index either, which might significantly change the findings regarding some of the authors, or individual scientific fields.

Thus, the number of published works in the period from 1996 to 2005, the number of citations from those papers and their *h*-index in the WoS and Scopus databases were determined and examined for each author, or, more precisely, 807 doctors of the social sciences and 1,131 doctors of the natural sciences, which was a very time-consuming task.

Since scientific fields are an important socio-cognitive framework of scientific productivity, and since earlier studies had determined the existence of disciplinary peculiarities, that is, differences in productivity in certain fields (Biglan, 1973, according to Prpić and Brajdić Vuković, 2009; Prpić and Brajdić Vuković, 2005; Kyvik, 2003; Prpić, 1991), we believed that each area (and field) should be approached independently. For that reason, we calculated the average number of papers per scientist for each individual scientific field, the range of the number of published papers, the percentage of doctors of science who did not publish any papers within the given period, both in WoS and in Scopus. Extreme values of the number of papers, citations and *h*-index were expressed, and specificities in publishing in Croatian journals included in WoS were highlighted. Descriptive analyses of differences, that is, specificities in terms of the mentioned indicators, were made for the social and natural sciences.

Since this paper is just the first step in more extensive research of scientific productivity and its impact, the task is primarily descriptive – to bring attention to an overview of the major characteristics of production and the impact of every individual field or area, leaving more complex analyses for future studies.

3. Results of the study

3.1. Productivity and visibility of social scientists

The social sciences, as well as the natural sciences, possess specificities that are expressed through the dominant type of publications in which the findings of studies are published, through the number of journals, citation habits, or, in one broader definition, through differences in scientific communication. In Croatia, the term "social sciences" encompasses the already mentioned fields of psychology, sociology, pedagogy, economics, legal science, special education, kinesiology and information science.

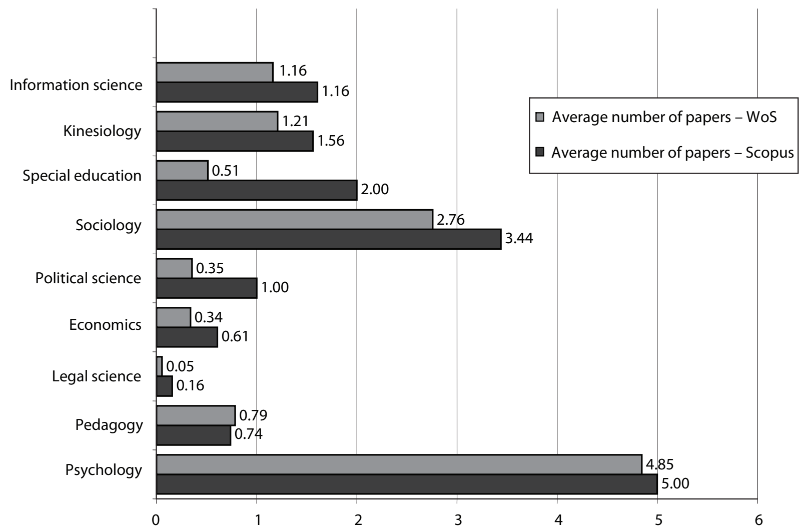
The study covered the population of 807 doctors of social sciences from the said scientific fields who published a total of 831 papers (Table 1) in the period from 1996 to 2005 according to the data from the SSCI-WoS database. The findings show that the average productivity of doctors of social science was 1 published work in a ten-year period.

Table 1. Scientific productivity of doctors of social sciences according to WoS and Scopus data in the period 1996-2005

Scientific field		0 papers (%)	1 – 5 papers (%)	6 – 9 papers (%)	10 and more papers (%)	Total papers
Psychology	**WoS**	**22.5**	**38.0**	**28.2**	**11.3**	**344**
(N=71)	*Scopus*	*16.9*	*40.8*	*31.0*	*14.1*	*355*
Pedagogy	**WoS**	**61.9**	**35.7**	**2.4**	**0**	**33**
(N=42)	*Scopus*	*61.9*	*35.7*	*2.4*	*0*	*31*
Legal science	**WoS**	**95.3**	**4.7**	**0**	**0**	**7**
(N=128)	*Scopus*	*89.1*	*10.9*	*0*	*0*	*20*
Economics	**WoS**	**84.5**	**14.9**	**0**	**0.6**	**105**
(N=309)	*Scopus*	*69.9*	*28.5*	*1.3*	*0.3*	*188*
Political science	**WoS**	**87.5**	**10.4**	**2.1**	**0**	**17**
(N=48)	*Scopus*	*79.2*	*16.7*	*0*	*4.2*	*48*
Sociology	**WoS**	**36.4**	**47.0**	**12.1**	**4.5**	**182**
(N=66)	*Scopus*	*37.9*	*40.9*	*12.1*	*9.1*	*227*
Special education	**WoS**	**69.2**	**30.8**	**0**	**0**	**20**
(N=39)	*Scopus*	*25.6*	*69.2*	*5.1*	*0*	*78*
Kinesiology	**WoS**	**62.5**	**33.3**	**2.1**	**2.1**	**58**
(N=48)	*Scopus*	*50.0*	*45.8*	*2.1*	*2.1*	*75*
Information sc.	**WoS**	**73.2**	**23.2**	**1.8**	**1.8**	**65**
(N=56)	*Scopus*	*60.7*	*30.4*	*5.4*	*3.6*	*90*
Total	**WoS**	**73.0**	**21.2**	**4.0**	**1.9**	**831**
	Scopus	*61.8*	*30.6*	*4.8*	*2.7*	*1112*

Analysing the share of productive scientists, that is, those who published at least one paper in the relevant period, we determined that the share is only 27%. This means that as many as 73% of doctors of social sciences did not transmit any scientific messages via the so-called most prestigious journals included in the SSCI-WoS database. The number of papers published per author ranged from 1 to 38, with only one author at the extreme end with 38 published papers. The highest percentage of scientists, 21.2% of them, published from 1 to 5 papers, while only 1.9% of them produced 1 or more papers per year. The papers published by the most productive 1.9% of scientists make up 29.1% of the total number of published papers. The average values of scientific productivity for individual fields within the social sciences are presented in Graph 1.

Graph 1. Average number of papers per scientist for particular fields of social sciences according to WoS and Scopus



The 831 papers published were cited 1,873 times in total, or 2.25 times per paper on average. We obtain a slightly different picture of the citation status when we take into account that out of 27% of scientists who published at least one paper, 61% of them earned one or more citations of their works, including all types of self-citation, while 39% of authors remained unnoticed as regards the citation of their papers.

Since there were not many comprehensive bibliometric studies made for the social sciences as a whole, there were few data to compare our findings. We took the data offered by ISI/Thomson in its commercial product, the statistics database Essential Science Indicators (1995–2005), as one of the landmarks.

According to these data, the average number of citations per paper in the social sciences at the global level was 3.38, not including economics. Considering all the specificities of the social sciences, especially their national orientation, our finding of 2.29 citations per paper, excluding economics, indicates much lesser visibility of papers from the social sciences created in Croatia (Table 2). However, when making this claim, one should certainly bear in mind the methodological limitations of the research arising from the fact that we did not study the precise time when the papers were published. More exactly, it is not at all irrelevant for the citation count whether a paper was published in 1996 or in 2005.

Table 2. Citation of doctors of social sciences according to data from WoS and Scopus in the period 1996–2005

Scientific field/ citation (author)		No citation (%)	Citation (%)	Total citations	Average number of citation per paper
Psychology	**WoS**	**14.5**	**85.5**	**1064**	**3.1**
	Scopus	*6.8*	*93.2*	*1489*	*4.2*
Pedagogy	**WoS**	**75.0**	**25.0**	**1**	**0.4**
	Scopus	*62.5*	*37.5*	*17*	*0.5*
Legal science	**WoS**	**66.7**	**33.3**	**9**	**1.3**
	Scopus	*85.7*	*14.3*	*18*	*0.9*
Economics	**WoS**	**43.8**	**56.2**	**211**	**2.0**
	Scopus	*64.5*	*35.5*	*167*	*0.9*
Political science	**WoS**	**50.0**	**50**	**6**	**0.4**
	Scopus	*50.0*	*50*	*16*	*0.4*
Sociology	**WoS**	**42.9**	**57.1**	**180**	**1**
	Scopus	*29.3*	*70.7*	*388*	*1.7*
Special education	**WoS**	**83.3**	**16.7**	**4**	**0.2**
	Scopus	*55.2*	*44.6*	*23*	*0.3*
Kinesiology	**WoS**	**5.6**	**94.4**	**247**	**4.3**
	Scopus	*25.0*	*75.0*	*268*	*3.6*
Information science	**WoS**	**53.3**	**46.7**	**140**	**2.2**
	Scopus	*54.5*	*45.5*	*245*	*2.7*
Total	**WoS**	**39.0**	**61.0**	**1873**	**2.3**
	Scopus	*44.5*	*55.5*	*2631*	*2.4*

It was possible to calculate the values of the *h*-index for the social sciences as a whole only for the mentioned 61% of authors who published at least one paper or were cited at least once in the relevant time span according to WoS data. The values obtained ranged from 1 to 6, with the majority of cited authors recording an *h*-index value of 1 (57.9% of them). Only 9% of authors had an *h*-index of 4 or over (Table 3).

Table 3. Values of the *h*-index for social sciences (cited authors) according to WoS and Scopus (expressed in %)

Scientific field / *h*-index		1	2	3	4 and higher
Psychology	**WoS**	**46.8**	**29.8**	**12.8**	**10.6**
	Scopus	*50.9*	*21.8*	*12.7*	*14.5*
Pedagogy	**WoS**	**100.0**	**0**	**0**	**0**
	Scopus	*83.3*	*16.7*	*0*	*0*
Legal science	**WoS**	**100.0**	**0**	**0**	**0**
	Scopus	*100.0*	*0*	*0*	*0*
Economics	**WoS**	**66.7**	**22.2**	**7.4**	**3.7**
	Scopus	*72.7*	*24.2*	*3.0*	*0*
Political science	**WoS**	**100.0**	**0**	**0**	**0**
	Scopus	*80.0*	*20.0*	*0*	*0*
Sociology	**WoS**	**66.7**	**16.7**	**4.2**	**12.5**
	Scopus	*58.6*	*27.6*	*3.4*	*10.3*
Special education	**WoS**	**100.0**	**0**	**0**	**0**
	Scopus	*100.0*	*0*	*0*	*0*
Kinesiology	**WoS**	**35.3**	**47.1**	**5.9**	**11.8**
	Scopus	*50.0*	*22.2*	*10.0*	*16.7*
Information science	**WoS**	**57.1**	**28.6**	**0**	**14.3**
	Scopus	*60.0*	*10.0*	*10.0*	*20.0*
Total	**WoS**	**57.9**	**25.6**	**7.5**	**9.0**
	Scopus	*63.2*	*20.5*	*7.0*	*9.4*

In contrast to the scientific production of Croatian social scientists referenced in the WoS database as described above, our expectations regarding the Scopus database were somewhat different. We assumed that the data obtained from the Scopus database would provide a slightly different picture, at least in terms of the number of published papers. Our assumption was based on the fact that Scopus includes a greater number of local and international journals than WoS. The data obtained (Table 1) show that our corpus of scientists published more papers indexed in Scopus than in the WoS base, 1,112 in total. The average number of publications per scientist was 1.4. However, only 38.2% of scientists published, or, in other words, 61.8% of social scientists did not publish any papers in the analysed period. The number of published papers ranged from 1 to 41, with only one scientist publishing the extreme number of papers. On average, only 2.7% of scientists published 1 or more papers per year in the relevant period, with only two authors publishing 35, or 41 papers within the ten years. Those 2.7% of scientists published 30.26% of papers in total.

The published papers had 2,631 citations in total, which is 2.4 citations on average per paper. In fact, 55.5% of authors had 1 to 404 citations of their works in the period 1996–2005. In other words, 44.5% of scientists who published at least one paper, and in reality as many as 6 papers, were not cited once. In this case too, as in the case of WoS, the warning applies regarding the methodological limitation of the study regarding the lack of information on the time the papers were published.

According to the citation count, 171 scientists had an *h*-index value of at least 1, which makes up 21.2% of scientists in total. The *h*-index ranged from 1 to 7, with 63.2% of scientists for whom the value could be calculated scoring 1 on the *h*-index. Only 9.4% of cited scientists had an *h*-index value of 4 or higher.

A more comprehensive overview of the specificities of scientific activity of our population of scientists, measured by publishing production and impact as reflected in the number of citations for overall social sciences, is obtained by an analysis of each individual field (Tables 1, 2, and 3, and Graph 1). Since there was a wealth of data for every discipline, we are not able to analyse each of them individually. Instead, we focus on making a synthesis and in summing up the most relevant and most interesting findings.

As we can see from Graph 1 and Table 1, psychology stands out as the social discipline with the biggest average number of published articles in the analysed period. Sociology follows with lower average production, which, however, still stands out noticeably from the average production of the other social disciplines. Our data, WoS and Scopus, indicate that these two fields also have the lowest proportion of unproductive scientists who did not publish a single article in ten years. Psychology is the absolute leader here as well, with "only" 22.5% of unproductive researchers, a share very similar to that of the natural sciences. Another relevant piece of information is that over one half of papers authored by psychologists were published in renowned international journals. The share of papers that psychologists publish in the local journal *Društvena istraživanja (Social Studies)* is also relatively high. However, although psychology and sociology are the most productive social disciplines, it is important to highlight the differences between them. Thus, it is obvious that psychologists are not only more productive than their colleagues in the field of sociology, but they are also focused on renowned international journals.

The leading position of psychology, followed by sociology as the most productive social disciplines can be partly explained by the nature of the subject and topics of these two social disciplines, especially psychology. The general nature of the topics of psychology favours publication in international journals. At the same time, the relatively high average production in sociology can be explained by the relatively high frequency of local sociological journals in the analysed databases, especially in Scopus. Thus, it is logical for the quantity of their scientific communication, measured by publishing, to be significantly higher than average in the social sciences.

In terms of the average output referenced in the WoS and Scopus databases, scientists in the field of information science and kinesiology are lagging slightly behind psychologists and sociologists, with an average output hovering around the social scientists' average.

It is very interesting that economists, one of the most productive groups of social scientists on the global scientific scene, turned out to be the least productive, together with legal scientists. Unfortunately, the real reasons for the extremely low scientific output of the greatest number of doctors of economic sciences in the world's most prestigious economics journals remains to be investigated in the future. With regard to legal science, one should have in mind the specificities of scientific communication within the legal sciences as a field, as well as the potential interest of the international scientific public in the law of a small transitional country. It is also important to consider the publishing habits and the system of evaluating the published works of our scientists–lawyers. It is well-known that all law schools in Croatia have their own journals and that the majority of scientists, who are also university professors, publish various monographs.

Graph 1 also indicates that social scientists are in general somewhat more productive in the Scopus database than in WoS. This is most evident in two social fields: special education and political science. As we have already explained, the Scopus database covers a much broader spectrum of journals, at least those preferred by Croatian disability and political scientists, but also social scientists. Doctors of special education from our population largely publish in local journals, primarily in *Hrvatska revija za rehabilitacijska istraživanja (Croatian Review of Rehabilitation Research),* and this in over 80% of cases. It is also interesting that the majority of papers, over 90% of them, represented in the Scopus database published by political scientists, were published in Croatian journals of a relatively broad spectrum – ranging from the journal *Socijalna psihijatrija (Social Psychiatry), Promet (Transport), Građevinar (Civil Engineer), Pomorstvo (Journal of Maritime Studies), Socijalna ekologija (Social Ecology), Alcoholism, Društvena istraživanja (Social Studies)* to *Hrvatska revija za rehabilitacijska istraživanja (Croatian Review of Rehabilitation Research).*[6] A lesser number of papers was also published in internationally renowned journals such as *Electoral Studies* or *International Social Work*.

If we analyse the citation count (Table 2), we will see that kinesiologists (alongside psychologists) are among the social scientists whose papers have the biggest impact. The two fields also have the lowest share of uncited authors. The results for psychology were expected. Even though we initially found an explanation for the high citation of publications authored by kinesiologists in the interdisciplinary nature of the field and its methodology which is close to that used by the natural and biomedical sciences, the real reason was determined only after a more detailed citation analysis. The above-average self-citation rate influenced the relatively high number of citations per paper. For this reason, the data, which at first sight suggest a relatively high level of visibility of Croatian kinesiologists in the WoS, distort to a certain extent the real picture of the impact of kinesiology papers.

The least cited publications are those authored by scientists from the fields of pedagogy, political science and special education. If we attempt to explain the results, we should certainly consider the specificities of these social disciplines that can explain their slighter impact. However, the most probable causes lie in the publishing habits. Primarily, the habit of publishing in Croatian journals, which publish only papers in the Croatian language, makes these works inaccessible to the potentially interested international scientific community. The existing system of evaluating scientific work and of promotion to academic degrees and scientific ranks which does not encourage scientists to publish in prestigious international journals presents an additional problem. We believe that the fact that the field of pedagogy has the

[6] The *Politička misao (Political Thought)* journal, as the leading Croatian political science journal, was not indexed in the WoS and Scopus databases in the analysed period.

longest tradition in publishing a scientific journal also carries weight. The *Napredak* (Progress) journal has been issued without any interruptions, and with several changes of title, since 1857 and is in a way a landmark in scientific communication. This is the reason why our results concerning the publishing and visibility of papers in pedagogy were to a certain extent unexpected.

Information science and economics earned citation rates very close to the average for social scientists' publications, but only in WoS publications. It is interesting that economics, one of Croatia's least productive social disciplines, has a citation rate for its publications in the WoS database very close to the average citation rate for social sciences. A possible explanation is that economics publishes "little, but of quality". Furthermore, since economics is a very extensive and "densely populated" discipline, with the greatest number of scientists of all social sciences (in Croatia), it is clear that the number of persons potentially interested in various topics is much greater than in some "scarcely populated" disciplines.

From the aspect of the *h*-index (Table 3), which combines citation and average productivity, psychology fared best, followed by kinesiology, sociology and information science. If we compare our findings for information science (Table 3), for example, with the data obtained by Cronin and Meho (2006) and Oppenheim (2007), we would hardly be satisfied. Cronin and Meho were the first to conduct a study comparing the *h*-index and the total number of citations for information science. However, since this was an analysis of the 31 most cited scientists from information science faculties in the USA in the period from 1999 to 2005 according to the *SSCI most cited IS scholars,* and our analysis is based on all scientists, it would be unfair to draw comparisons. We can only mention incidentally that the *h*-index ranged from 5 to 20 in the said study. The authors proved that there was a strong positive correlation between the *h*-index and the number of citations, suggesting that the total citation count was indeed a reliable indicator of the impact and influence of scientists' papers. The mean value of the *h*-index for information science was 11, with the highest extreme reaching 19, and the lowest 5, excluding self-citations. Oppenheim analysed British scientists from the field of Library and Information Science, calculating the mean *h*-index value at 7. Since the findings of his study do not refer only to eminent scientists, they are comparable to ours. Table 3 shows that Croatian information science scholars largely have an *h*-index of

1. Alongside the fact that information science is a young and smaller field (Cronin and Meho, 2006), and especially in Croatia, the findings of our study could be additionally explained by the specificities in the subfields, the smaller pool of scientists, or the lack of critical mass, as well as by the extremely great dispersion by various institutions.

3.2. Productivity and visibility of natural scientists

The situation regarding the classification of natural sciences seems much clearer at first sight when compared to the specificities of the social sciences in Croatia and in ISI. However, difficulties arise when the two systems have to be harmonised. ISI/Thomson uses different classification systems depending on the database. Thus, in the case of the JCR (Journal Citation Reports) database, the natural and applied sciences are classified in 169 fields and subfields, while the Essential Science Indicators database uses a system of 22 fields for the whole science. If we decide to follow the Essential Science Indicators system, which we consider more acceptable in terms of depth of classification, difficulties arise concerning biology and chemistry, and even more so in the case of physics. The field of biology is a single field according to the Croatian classification system, but it includes as many as 5 out of 22 fields according to ISI, these being: Biology & Biochemistry, Environmental Sciences/Ecology, Microbiology, Molecular Biology & Genetics, and Plant & Animal Science. We present this example only as an illustration, in order to avoid misunderstandings in the interpretation of results.

Our population of natural scientists is made up of 1,131 doctors of science from the fields of mathematics, physics, chemistry, biology, geology and geography.

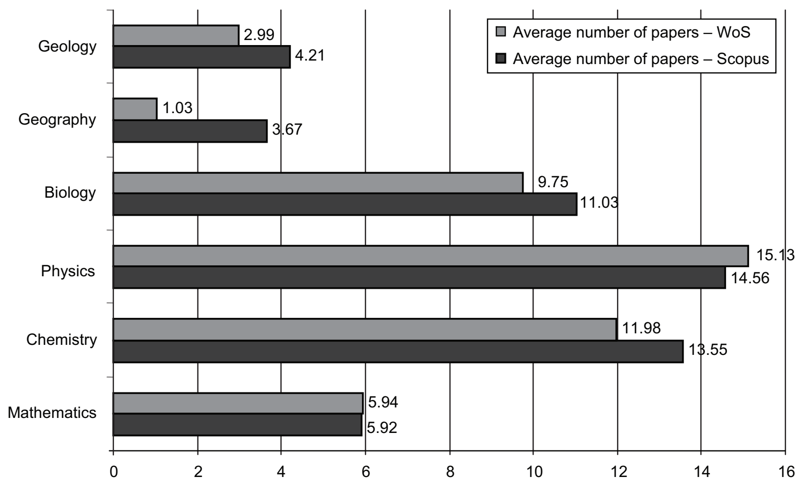
According to the SCI-expanded WoS data, the scientists published a total of 11,925 papers in the period from 1996 to 2005, an average of 10.5 papers per author. Statistically, every scientist published at least 1 paper for every year of the studied period. In fact, papers were published by 88.4% of scientists, while 11.6% of doctors of natural sciences published no papers registered in the SCI Expanded WoS database (Table 4).

The number of papers published per author ranged from 1 to 162, with 44.2% of authors publishing 1 to 16 papers per year on average. These 44.2% of authors published 77.1% of the papers. Average scientific productivity values for individual fields within the natural science are presented in Graph 2.

Table 4. Scientific productivity of doctors of natural sciences according to the WoS and Scopus data in the period from 1996 to 2005

Scientific field		0 papers (%)	1 – 9 papers (%)	10 and more papers (%)	Total papers
Mathematics	**WoS**	**26.8**	**57.5**	**15.7**	**754**
(N=127)	*Scopus*	*26.8*	*59.1*	*14.2*	*752*
Chemistry	**WoS**	**6.4**	**46.6**	**46.9**	**5031**
(N=420)	*Scopus*	*7.4*	*39.8*	*52.9*	*5693*
Physics	**WoS**	**3.0**	**38.8**	**58.2**	**3510**
(N=232)	*Scopus*	*4.3*	*38.3*	*57.3*	*3377*
Biology	**WoS**	**6.2**	**59.6**	**34.2**	**2369**
(N=243)	*Scopus*	*7.0*	*49.0*	*44.0*	*2680*
Geography	**WoS**	**60.6**	**39.4**	**0**	**34**
(N=33)	*Scopus*	*6.1*	*84.5*	*6.1*	*121*
Geology	**WoS**	**36.8**	**56.6**	**9.2**	**227**
(N=76)	*Scopus*	*17.1*	*71*	*11.8*	*320*
Total	**WoS**	**11.6**	**49.4**	**39.1**	**11925**
	Scopus	*9.5*	*47.1*	*43.4*	*12943*

Graph 2. Average number of papers per scientist for individual fields of natural sciences, according to WoS and Scopus



The 11,925 papers published in journals indexed in the WoS database earned a total of 74,842 citations, with an average of 6.3 citations per paper (Table 5). Out of the 1,000 scientists who published at least one paper, 5.4% of them did not receive a single citation, including self-citations. We were not able to make a comparison with the Essential Science Indicators that we made for the social sciences due to differences in the classification of science.

Table 5. Citation of doctors of natural sciences according to the WoS and Scopus data in the period from 1996 to 2005

Scientific field/ citations (authors)		Uncited (%)	Cited (%)	Total citations	Average number of citations per paper
Mathematics	**WoS**	**12.9**	**87.1**	**2105**	**2.8**
	Scopus	*17.2*	*82.8*	*2233*	*3.0*
Chemistry	**WoS**	**2.8**	**97.2**	**31395**	**6.2**
	Scopus	*3.1*	*96.9*	*35678*	*6.3*
Physics	**WoS**	**0.9**	**99.1**	**28702**	**8.2**
	Scopus	*1.8*	*98.2*	*24292*	*7.2*
Biology	**WoS**	**6.6**	**93.4**	**11345**	**4.8**
	Scopus	*3.5*	*96.5*	*13625*	*5.1*
Geography	**WoS**	**76.9**	**23.1**	**21**	**0.6**
	Scopus	*48.8*	*51.2*	*59*	*0.5*
Geology	**WoS**	**8.3**	**91.7**	**1274**	**5.6**
	Scopus	*20.6*	*79.4*	*1464*	*4.06*
Total	**WoS**	**5.4**	**94.6**	**74842**	**6.3**
	Scopus	*6.6*	*93.4*	*77351*	*6*

Values of the *h*-index for scholars from all the natural sciences together ranged from 1 to 20 and could be ascribed to the majority of 83.6% of scientists, that is, 94.6% of authors. The *h*-index could not be calculated for 16.3% of doctors of natural sciences who make up the group of doctors of natural sciences who did not publish any papers or who did not receive any citations. An *h*-index value of 1 was determined for 15.5% of cited authors. An *h*-index value of 10 and above for the natural sciences taken as a whole is considered a very high value, which means that each of the authors published at least 10 papers and that each of the papers received at least 10 citations (Table 6). The category of the most productive and most cited authors is made up of 4.6% authors.

As we have already mentioned, the *h*-index was introduced as a scientometric indicator in 2005, which is the reason why relatively few study results have been published so far. The results obtained by Iglesias and Pecharroman (2007) can serve for at least a partial comparison with our findings. Their data show that biologists have an almost two times greater *h*-index than physicists, which was not established in our case.

Table 6. Values of the *h*-index for natural sciences (cited authors) according to WoS and Scopus expressed in (%)

Scientific field/ h-index		1	2	3	4 and higher
Mathematics	**WoS**	**40.7**	**28.4**	**11.1**	**19.8**
	Scopus	*39.0*	*26.0*	*10.4*	*24.7*
Chemistry	**WoS**	**10.7**	**14.9**	**18.1**	**56.3**
	Scopus	*11.4*	*15.4*	*13.3*	*59.9*
Physics	**WoS**	**9.4**	**11.2**	**18.4**	**61.0**
	Scopus	*10.1*	*11.5*	*17.9*	*60.6*
Biology	**WoS**	**18.8**	**21.1**	**18.8**	**41.3**
	Scopus	*15.1*	*18.3*	*19.3*	*47.2*
Geography	**WoS**	**33.3**	**66.7**	**0**	**0**
	Scopus	*75.0*	*25.0*	*0*	*0*
Geology	**WoS**	**25.0**	**36.4**	**22.7**	**0**
	Scopus	*30.0*	*28.0*	*26.0*	*16.0*
Total	**WoS**	**15.5**	**17.8**	**17.9**	**48.8**
	Scopus	**16.2**	*16.8*	*15.9*	*51.0*

According to the data obtained from Scopus, our population of doctors of science from all fields of the natural sciences published 12,943 papers in total, which averages 11.4 papers per scientist. In reality, 90.5% of scientists published that number of papers, that is, 9.5% of scientists did not publish any papers in the given period. Furthermore, 43.3% of scientists published one or more papers per year on average. The number of published papers ranged from 1 to 156 in total, with only one author publishing 156 works. This finding bears even greater relevance due to the fact that the papers are from the field of mathematics, where at the global level the average number of works published per author in one year was considerably lower than the result achieved by the author from our population!

The mentioned 12,943 papers received 77,351 citations in total, which makes up an average of 6 citations per paper. The authors who did not receive a single citation made up a group of 2.8% of the overall population of doctors of natural sciences, and 6.6% of authors were not cited at all.

The values of the *h*-index ranged from 1 to 22 per scientist. For 15.6% of scientists from the total population of natural sciences it was not possible to calculate an *h*-index, while 13.7% of them had an *h*-index of 1. Values of 5 and higher were determined for 31.5% of scholars.

A more comprehensive picture of scientific productivity and its impact on individual fields of natural sciences can be obtained on the basis of the information from Tables 4, 5, and 6, and Graph 2.

We have to point out once again that we are not able to analyse every discipline individually due to the excessive amount of data, which is why we will focus only on summing up the most relevant findings.

If we look at the findings for scientific productivity, citation and the value of the *h*-index, we notice that the physicists from our corpus rank first. They have on average the greatest number of papers per scientist, the greatest number of authors with 10 or more papers in the said period, that is, they have the most authors with at least one paper per year, and this according to both WoS and Scopus. Their papers also have the greatest average number of citations, and the authors have on average the greatest *h*-indices. According to Hirsch (2005), the creator of the indicator, a "successful physicist" should have an *h*-index of 20 over 20 years, while an "extraordinary physicist" should have an *h*-index of 40, and a "truly unique individual" 60 and more. If we take into account that our study covered a period of ten years, we already have physicists who meet the criteria of "successful physicists". To be more precise, 9.5% of physicists from our population have an *h*-index between 10 and 20 (Table 6).

Chemistry follows physics in all criteria, and biology ranks third, while geology ranked third only in terms of the average number of citations per paper.

If we compare our results with the global average according to the 1995–2005 Essential Science Indicators for an average number of citations per paper in these three fields, then physicists have above-average results, chemists are relatively close to the global average, and biologists have considerably poorer results on average. The said finding can be explained by the established standards of scientific communication in these fields, and by the relevant ministry's evaluation system. Physicists, chemists and the majority of biologists, especially molecular biologists and geneticists, are simply not recognised within relevant scientific circles unless they publish in prestigious international journals. It is important to point out that none of the Croatian physics journals is included in the WoS-SCI Expanded database, which means that all physicists' papers were published in prestigious international journals. However, some chemists published a greater share of their papers in the Croatian journals *Croatica Chemica Acta* and *Chemical and Biochemical Engineering Quarterly*. At the same time, it is important to say that even the most productive chemists published in the most prestigious international journals. This especially refers to the chemists from the Ruđer Bošković Institute. In order to give a full overview, we should also state that all the mentioned papers were co-authored by five or more authors per paper, which is an accepted publishing model in chemistry at the global level.

The biologists from our sample are engaged in a relatively broad spectrum of research in the field of biology – from botany, zoology, marine biology, ecology to molecular biology, which is also evident from the 36 different institutions in which they are working. This diversity is manifested in the specificities of scientific communication, and it is difficult to expect equal scientific productivity from biologists engaged in plant biology or zoology, environmental research, biodiversity or molecular biology. Our preliminary studies show that biologists, unlike physicists and some chemists, cooperate less with colleagues from abroad, and they publish papers with fewer co-authors. In order to obtain a more comprehensive insight, it should be mentioned that some of their works were published in Croatian journals indexed in WoS – *Periodicum biologorum* and *Collegium antropologicum*.

Mathematics has a special place in our study for several reasons, but primarily due to a high average number of citations per paper (Table 5) compared to the global average, which came to 2.6 citations per paper in the period from 1995 to 2005 according to Essential Science Indicators. It also has a special place for having one author publish 162 papers in ten years, which is rare even in the world's strongest scientific communities. However, the fact that this scientist is an editor of the *Mathematical Inequalities & Applications* journal, which has been indexed by SCI since its first issue, might shed some light on this peculiarity. The third specificity of this discipline is the relatively high share of authors who published at least one paper per year in the studied period (Table 4).

Geology has for a long time had the status of a so-called national science in Croatia. In practice, this has included the administrative control of publishing research results, which did not necessarily favour publishing in international journals. However, the presented findings indicate that the situation has been changing significantly (Table 4, 5 and 6, and Graph 2). It is especially important that geologists' published papers received 5.6 citations on average, which can be considered relatively satisfactory, compared to the 1995–2005 Essential Science Indicators (7.49 citations per paper). According to the data from WoS, all these papers were published in relevant international journals.

Geography certainly has a special place in the natural sciences. Anglo-American classifications of science categorise geography partly as one of the geosciences, and partly as a social science, which is also important for the interpretation of the data obtained in this study (Table 4, 5 and 6, and Graph 2). Thanks to its peculiar characteristics in the system of natural sciences, geography unsurprisingly manifested significant discrepancies from the model of scientific communication of other natural sciences. As expected, Scopus produced a significantly greater number of papers than WoS, since it covers Croatian journals from the field of geography. We expected the papers to be potentially interesting to the European scientific community, but that was not the case. One of the reasons may be the fact that the papers were written in Croatian and they were not quite accessible to potentially interested scientists. An analysis of journals where the mentioned papers were published showed that over 90% of them were Croatian, most of all *Društvena istraživanja (Social Studies)* and to a lesser extent *Periodicum biologorum*.

4. Conclusion

This study is the first in Croatia to show precise data on the scientific productivity (and its impact) of doctors of the social and natural sciences in the period from 1996 to the end of 2005, based on a search of the WoS (SSCI and SCI-expanded) and Scopus citation databases.

However, let us highlight several important facts first. First, bibliometric analyses such as this one that cover exclusively output published in journals indexed in the WoS and Scopus databases favour the natural sciences. The limitations of this method have to be highlighted in order to avoid inaccurate generalisations of results to overall production, which in social sciences also includes journals indexed by other relevant databases. It is also indisputable that the share, importance and influence of books are incomparably greater in the social than in the natural sciences, which are dominated by journal articles (Prpić and Brajdić Vuković, 2009).

Secondly, co-authorship is the prevailing form of scientific production in the natural sciences (Kyvik, 2003), while the proportion of co-authored papers is lower in the total number of publications in the social sciences (Prpić and Brajdić Vuković, 2009). Since co-authored articles were ascribed to each author in this study, it is very likely that the natural sciences were additionally favoured in terms of the quantity of papers, since co-authorship is still much more common to the natural sciences.

Thirdly, natural scientists are more focused on the international scientific community and are more inclined to publish in international journals. Social scientists, however, more often publish in national and regional journals due to their primary focus on the study of their own society. However, social sciences are also ever more present on the international scientific scene (Nederhof et al., 1989; Hicks, 1999; Nederhof, 2006).

The fourth fact concerns bibliographic and citation databases, especially WoS. Journals from the natural sciences are far more represented in that database than those from the social sciences (Nederhof, 2006), and thus it is logical to expect natural scientists to have greater output.

Considering the facts stated in the recapitulation above, we are driven to the following conclusions. The first is that there are various differences in the analysed characteristics between the two fields. Although the natural sciences are probably favoured for the above-stated reasons, the existing differences are still sufficient to draw tenable conclusions.

Thus, the natural sciences absolutely dominate the social sciences in terms of WoS and Scopus productivity, citations and the *h*-index. The fact that, according to WoS, the average number of papers per scientist in the social sciences was 1, and in the natural sciences 10.6, is very indicative. In the social sciences, 73% of scientists did not publish a single paper referenced in the WoS, while there were only 11.6% of such scientists in the natural sciences. In terms of the impact of scientific activity, measured by the number of citations (WoS) for social sciences as a whole, the average citation rate was 2.25 per paper. The impact of scientific activity was very different in the natural sciences – the average number of citations per paper was 6.3. The *h*-index for the social sciences ranged from 1 to 6, and it could be calculated only for 16.5% of scholars. The natural sciences, however, had an *h*-index ranging from 1 to 20, and the values could be calculated for as many as 87% of scientists.

It is important to point out that the natural sciences, compared to the social sciences, not only keep up with the average international figures, but often fare above average. Thus, in the natural sciences, physics and mathematics are above average by all indicators compared to other fields, but also compared to average global results.

Social scientists, however, still lag behind the global indicators, which can be explained in the following way. Firstly, Croatian social scientists are more focused on investigating their own society, and they are thus more inclined to publish in national journals. Secondly, only a small share of the local social journals is indexed in the WoS database. Thirdly, Croatian social scientists publish in Croatian journals that are included in the WoS, with the *Društvena istraživanja (Social Studies)* journal holding a special place. There is no need for any special discussion on the importance of publishing papers in English for transmitting scientific information to the relevant scientific community. National journals included in WoS have a special place in the natural sciences as well, especially in biology and chemistry, but, unlike the *Društvena istraživanja (Social Studies)* journal, they publish all their papers in English. The fourth reason why social scientists lag behind can also be found in the internal norms, that is, the "criteria and models" of scientific communication that exist in different social disciplines. We could say that there has been much less encouragement in the social sciences to publish in renowned international journals than in the natural sciences.

The second conclusion of our study undoubtedly indicates that the differences in the basic characteristics that we have analysed show a relatively great oscillation between disciplines. Each field has its own peculiarities and the criteria that seem suitable for one field do not have to be appropriate for all disciplines. Thus, for example, one certainly needs to question the validity of using the WoS or Scopus database as a measuring instrument (in awarding a scientific rank, or the like) in fields such as legal science, where over 90% of scholars have been excluded. Furthermore, although it is categorised only as a natural science in our official classification of scientific fields, geography is much more similar to the social than to the natural sciences in terms of the results obtained regarding its scientific productivity and impact. Thus, not only should the bibliometric monitoring of publications from the field of the social sciences and humanities not rest on the same methodological assumptions that apply to the natural sciences (Prpić and Brajdić Vuković, 2009), but it is also clear that different disciplines within the same area have different patterns of scientific communication. One should certainly bear this in mind when creating a science policy and criteria for promotion in science.

The third conclusion of this study regards the comparison of the two bibliographic and citation databases used in the research. Even though we assumed that scientific output would be much greater, especially for the social sciences, the results do not completely support this thesis.

To conclude, our comparative study of productivity in the natural and social sciences and their respective individual disciplines supports the already familiar thesis on the specificities of scientific fields and their patterns of productivity. It confirms that the indicators and standards of average scientific output and impact that apply to the natural sciences cannot be uncritically transferred and applied to the social sciences.

Since this study has provided only indications of scientific productivity and impact for the social and natural sciences in Croatia and on a specific population, a deeper insight into scientific productivity referenced in the WoS and Scopus databases would require additional research and analysis.

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