FUNDING PATTERNS OF BIBLIOMETRICS RESEARCH

MODELI FINANCIRANJA BIBLIOMETRIJSKIH ISTRAŽIVANJA

Peter Kokol

Faculty of Electrical Engineering and Computer Science, University of Maribor, Maribor, Slovenia
Fakultet elektrotehnike računarstva, Sveučilište u Mariboru, Maribor, Slovenija

Abstract

To identify research funding patterns behind bibliometrics as a rapidly expanding science was the aim of the study presented in this paper. We analysed funding information of 8,622 bibliometric papers harvested from Web of Science, among which 1,786 (20.7%) were Papers with Reported Funding (PRFs). The trend in number of PRFs funding in last five years was positive. The most productive countries in PRFs` production were China, the USA and the UK. The same countries were also the most prolific regarding how many times they were mentioned in funding acknowledgements. The number of PRFs published per country was related with OECD reported Gross Domestic Spending on R&D for 2015. There was a significant correlation between number of PRFs per country and the number of all bibliometric papers per country. Far the most prolific funding agency was National Natural Science Foundation of China, followed by the European Commission and the USAs National Science Foundation. The Research trend and direction prediction is the most prolific research theme regarding the percent of PRF and thus most likely to get funded.

Sažetak

Cilj istraživanja predstavljenog u ovom radu bio je identificirati obrasce financiranja istraživanja iz područja bibliometrije kao znanosti koja se brzo širi. Analizirane su informacije o financiranju 8.622 bibliometrijskih radova prikupljenih iz Web of Science, od kojih je 1.786 (20,7%) bilo radova s prijavljenim financiranjem (PRF). Trend u broju PRF-ova u posljednjih pet godina bio je pozitivan. Najproduktivnije zemlje u proizvodnji PRF-a bile su Kina, SAD i Velika Britanija. Iste su zemlje bile i najplodnije u pogledu koliko su puta spomenute u priznanjima za financiranje. Broj PRF-ova objavljenih po zemlji povezan je s OECD-ovim izvješćem o bruto domaćoj potrošnji na istraživanje i razvoj za 2015. Postoji značajna korelacija između broja PRF-ova po zemlji i broja svih bibliometrijskih radova po zemlji. Daleko najplodnija agencija za financiranje bila je Nacionalna zaklada za prirodne znanosti u Kini, a slijede je Europska komisija i Nacionalna zaklada za znanost SAD-a. Predviđanje trenda i smjera istraživanja je najplodnija tema istraživanja u odnosu na postotak PRF-a i stoga najvjerojatnije da će se financirati.

INTRODUCTION

Bibliometrics is a rapidly expanding science with increased translation to practice in different application areas /**1**/, /**2**/. The identification of research funding patterns behind the expansion, was the aim of the study presented in this paper. The results of such studies might in-form an interested researcher about possible sources of funding, since there are too many funding agencies to be aware of all of them. Additionally it may point him to successful institutions which could be sought for possible partnerships, and help him to identify research themes and application areas most likely to be

funded. While it is hard to get data about funding from funding bodies, especially about specific research fields like bibliometrics, we followed Wang and Shapira /3/ proposal that funding acknowledgements found in bibliographical databases could be analysed to extract funding patterns. However, Rigby /4/ and Tang, Hu and Liu /5/, warned that, due to discrepancies in funding acknowledgements, the uncritical use of funding information may lead to bias in interpreting the results of such analyses. Due to their accuracy /6/ we used funding information provided in Web of Science (WoS, Clarivate Analytics, USA) database in the analyses performed in our study.

METHODS

The bibliometric research papers were harvested on 5th of February, 2018, from the WoS - All databases collection using advanced search. The search strings *TS = (bibliometric*) and PY = (2012-2017) and FO = (a* or b* or c* or d* or e* or f* or g* or h* or i* or j* or k* or l* or m* or n* or o* or p* or q* or r* or s* or t* or u* or v* or z* or x* or y* or w* or 1* or 2* or 3* or 4* or 5* or 6* or 7* or 8* or 9* or 0*)* was used for identifying funded papers, and the string *TS = (bibliometric*) and PY = (2012-2017)* for all bibliometric papers. The country, institution and funding agencies names in WoS are stored without strict standards /7/. Thus, we analysed extracted names manually, and merged variations into one entity, for example People R China and China into China; England, the United Kingdom and UK into UK: USA, the United States, and the United States of America into USA; Brazil and Brasil into Brazil; University of Harvard and Univ Harvard into University of Harvard; EU, EC, European Commission and European Union into EC, and similar. All country names were analysed. However, due to the fact that there were 7,477 different institution names (5,576 with occurrence less than 3) and 1,931 funding agencies names (1,810 with occurrence less than 3), we analysed and merged only the names for 10 productive institutions and 20 most prolific funding agencies. The analysis process is shown in Figure 1.
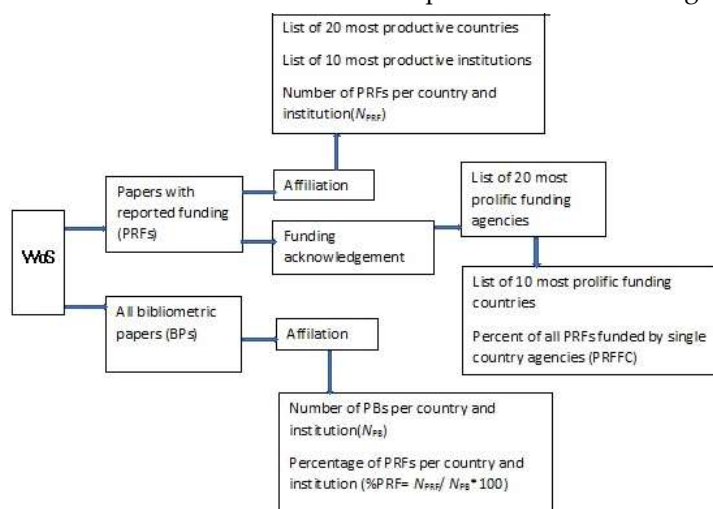

Figure 1. The block diagram of the analysis process

Additionally, abstracts and titles of funded papers were analysed using the VOSViewer software. General and common terms were excluded from the analysis. A cluster map was generated using terms with occurrence larger than 30. The cluster map was analysed using thematic analysis to identify the funded research themes and application area. For each theme we calculated its respective %PRF.

RESULTS AND DISCUSSION

The search resulted in 8,622 papers, among them 1,786 (20.7%) PRFs. This is, for example, less than in Robotics, where there were 31% of PRFs /7/, and more than in Nursing

Informatics, where there were 15% of PRFs /8/. The trend in production of BPs, PRFs and percentage of PRFs is positive (Figure 2). Compared to the trend in overall production of research papers the trend in production od BPs was steeper. The trend in the production of PRFs was smaller than both the trend in production of all papers and the trend in production of BPs.
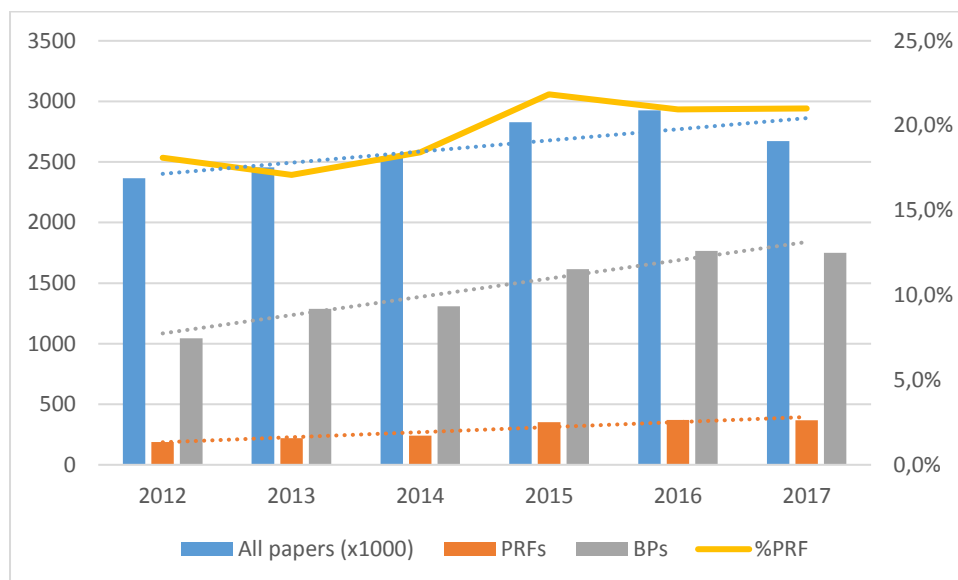

Figure 2. The trends in production of published papers and funding

Far the most prolific funding agency was National Natural Science Foundation of China, followed by the European Commission and the USAs National Science Foundation (Table 1). On the country level, China was the most prolific funding country (PRFFC=38.9%), followed by the USA (PRFFC=10.3%), Brazil and Spain (PRFFC=6.3%), the EC (PRFFC=5.8%), Canada (PRFFC=4.1%), the UK (PRFFC=3.4%) . Japan (PRFFC=3.0%), South Korea (PRFFC=2.4%) and Russia (PRFFC=1.7%). These country ranks are, with some exceptions, congruent with the OECD reported Gross Domestic Spending on R&D for 2015 /9/, where the USA is ranked 1st, China 2nd, Brazil 10th, Spain 15th, EC 3rd, Canada 13th, the UK 8th, Japan 4th, South Korea 6th and Russia 9th.The differences in ranking could show that countries like Canada, Brazil and Spain are investing more in bibliometric research, than in research in general.

Table 1. The 20 most prolific funding agencies

FUNDING AGENCY	N_{PF}
NATIONAL NATURAL SCIENCE FOUNDATION OF CHINA	205
EUROPEAN COMMISION	56
NATIONAL SCIENCE FOUNDATION (USA)	37
CNPQ (BRASIL)	33
SPANISH GOVERNMENT	32
FUNDAMENTAL RESEARCH FUNDS FOR THE CENTRAL UNIVERSITIES (CHINA)	30
NATIONAL INSTITUTES OF HEALTH (USA)	29
NATIONAL SOCIAL SCIENCE FOUNDATION OF CHINA	20
CAPES (BRASIL)	20
RUSSIAN GOVERNMENT	19

CHINA SCHOLARSHIP COUNCIL	17
CANADIAN INSTITUTES OF HEALTH RESEARCH	11
KOREAN GOVERNMENT	11
CHINA POSTDOCTORAL SCIENCE FOUNDATION	10
SWEDISH RESEARCH COUNCIL	10
MINISTRY OF EDUCATION SCIENCE AND TECHNOLOGICAL DEVELOPMENT OF THE REPUBLIC OF SERBIA	9
SAO PAULO RESEARCH FOUNDATION FAPESP (Brazil)	9
AUSTRALIAN GOVERNMENT	8
WELLCOME TRUST (UK)	8
ACADEMY OF FINLAND	7

The production of PRFs was distributed between 86 countries. The most productive countries were China, followed by the USA and the UK, producing more hen three quarters of RFPs. The overall production of bibliometrics papers was spread between 142 countries The most productive countries were USA, followed by China and the UK, producing cca. two fifths of BPs.

China was the most prolific country regarding $\%PRF_c$, followed by South Korea and Poland. Brazil and India, were the countries with the least $\%PRF_c$. This is surprising, given the high rank of Brazil in the list of most prolific funding countries. Despite the large difference between maximal (50.5%) and minimal (10.6%) $\%PRF_c$ the partial correlation test with the number of researchers per 1,000 inhabitants as a control variable showed a significant correlation between N_{PRF} and N_{BP} (R2=0.88,

p=0.00) That means that in general production of PRFs and BPs per country are proportionate. Most of the countries from Table 2 are also among 20 most productive countries regarding SciMago country rank. The only exceptions are Belgium and Malaysia, ranked 21st and 34th in the SciMago ranking. Two countries exceeding their ranks in SciMago are Spain and Brazil, ranking fourth (SciMago rank =10) and sixth (SciMago rank=15) respectively. That shows that the above four countries probably invest more in bibliometrics` research than in research in general. The Spearman test showed significant correlation between the country ranks regarding production of PRFs and SciMago Country ranks, meaning that, on average investment in bibliometrics are congruent with countries investments in science in general.

Table 2. The 20 most productive countries

COUNTRY	N_{PRF}	N_{BP}	$\%PRF_c$	SciMago country rank
CHINA*	647	1282	50,5%	2
THE USA*	405	1433	28,3%	1
THE UK*	237	873	27,1%	3
SPAIN*	148	699	21,2%	10
CANADA*	131	353	37,1%	7
BRAZIL*	78	733	10,6%	15
AUSTRALIA*	74	290	25,5%	11
THE NETHERLANDS	72	280	25,7%	14

GERMANY*	65	431	15,1%	4
SOUTH KOREA	61	140	43,6%	12
ITALY*	60	340	17,6%	12
SWEDEN	44	124	35,5%	18
FRANCE	42	192	21,9%	6
TAIWAN	38	200	19,0%	17
JAPAN*	36	121	29,8%	5
RUSSIA*	32	109	29,4%	13
BELGIUM	29	112	25,9%	21
MALAYSIA	29	73	39,7%	34
INDIA*	28	237	11,8%	9
POLAND	26	64	40,6%	19

*G20 countries

The most productive institutions (Table 3) are Chinese Academy of Sciences, Consejo Superior de Ivestigaciones Cientificas and Univeristy of Wuhan. Majority of the 10 most productive institutions are located in China and USA. Chinese institutions are also the most prolific regarding the %PRF$_i$, which for most Chinese institutions is larger than 70%. The largest %PRF$_i$ by a non Chinese institution was achieved by Georgia institute of technology (%PRF$_i$ = 56.0%).

Table 3. The 10 most productive institutions in bibliometric literature production

INSTITUTION	N_{PRF}	N_{BP}	%PRF$_i$
CHINESE ACADEMY OF SCIENCES	137	182	75,3%
CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS (Brazil)	91	244	37,3%
WUHAN UNIVERSITY (China)	88	119	73,9%
UNIVERSITY OF GRANADA (Spain)	77	188	41,0%
INDIANA UNIVERSITY SYSTEM (USA)	70	180	38,9%
GEORGIA INSTITUTE OF TECHNOLOGY (USA)	65	116	56,0%
UNIVERSITY OF MICHIGAN SYSTEM (USA)	54	152	35,5%
UNIVERSITY OF MONTREAL (Canada)	54	130	41,5%
PEKING UNIVERSITY (China)	53	116	45,7%
BEIJING INSTITUTE OF TECHNOLOGY	48	68	70,6%

The thematic analysis of the clusters and terms in Figure 3, revealed five research themes and 10 application areas emerging in funded research, namely:

- **Research evaluation, performance and funding** (yellow colour); %PRF=27%,
- **Information sciences and digital humanity** (violet colour);PRF=18%,

- **Analysis of publications and patents trends** in nanotechnology and health (blue colour); PRF=29%,
- **Research trends and directions prediction** in environmental sciences, chemistry, psychiatry and law, (green colour); PRF=32%,

- **Bibliometric, content and network analysis** in sustainability and management areas (red colour); PRF=28%.

The Research trend and direction prediction is the most prolific research theme regarding %PRF and thus most likely to get funded.
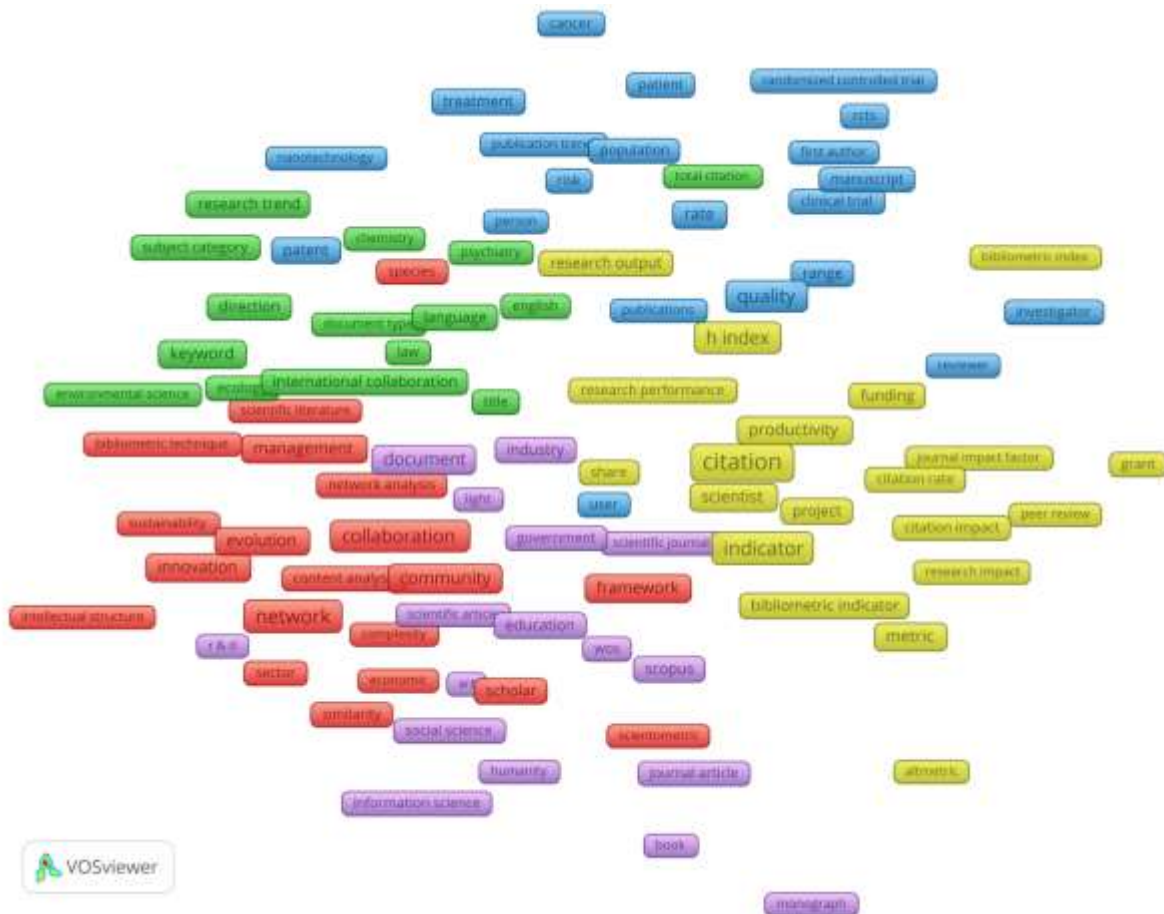

Figure 3. PRFs research themes and application areas

CONCLUSION

The trend in production of research papers in general, BPs, PRFs and percentage of PRFs was positive. However the trend in BPs production was steeper than overall production of research papers and also steeper than the production of PRFs. The most productive and prolific countries like China, the USA and the UK are also among the most productive regarding all scientific output. They are also most economically develop, being among G20 countries and have largest Gross Domestic Spendings on R&D. Far the most prolific funding agency was National Natural Science Foundation of China, followed by the European Commission and the USAs National Science Foundation. The most productive institutions are Chinese Academy of Sciences, Consejo Superior de Ivestigaciones Cientificas and the Univeristy of Wuhan. The Research trend and direction prediction is most likely to get funded.

Notes

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