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25TH ANNIVERSARY OF THE SCIENCE AND TECHNOLOGY INDICATORS CONFERENCE SERIES

CONFERENCE REPORT

This year's 18th STI conference marked the 25th anniversary of the Science and Technology Indicators Conference series. Organized by the iFQ – Institute for Research Information and Quality Assurance, the conference took place in the Berlin-Brandenburg Academy of Sciences and Humanities in Berlin on September 4-6. For the second time organized under the auspice of the European Network of Indicator Designers (ENID), the STI conference series provides an international forum for presenting and discussing new developments in constructing, using and interpreting science and technology indicators and the requirements for and the problems with generating the underlying data. By bringing together researchers, STI producers and users as well as other stakeholders, it thus aims to contribute to a better understanding with regard to

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STI indicators applied in different contexts which range from understanding institutional structures, developmental processes and contexts of science itself to their use as analytical tools in knowledge management and science policy decision making. It does so for exactly 25 years now since the first STI conference was held in Leiden in 1988.

Under the theme "Translational twists and turns: Science as a socio-economic endeavor" this year's conference attempted to particularly address the need of science itself which wants to better understand knowledge production as well as dissemination and transfer processes. Furthermore, the conference addressed

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the demand from science policy but also from various institutions, organizations at local, regional, national and international level which are increasingly asking for data to assess and compare the performance, position and interaction of the relevant actors in the STI system as well as the effects generated by science and its contribution to solve the so-called "grand societal challenges".

In order to address the theme of the conference, contributions on eight key topics were invited:

- Measuring and assessing benefits of science (including scientific outputs, innovation, social and environmental benefits)
- Knowledge transfer, knowledge exchange and specific issues relating to translational research
- Science push or pull factors for societal change
- Governance by competition: modes, instruments, effects and impacts of competition in research funding
- Impact of performance-based funding systems
- Production and reproduction of hierarchy: pros and cons of university rankings
- The geography of science and higher education systems: globalization, regionalization and localization processes
- Cross-sectorial research collaborations: fertilization or impediment?

Based on the assessment by at least two members of the scientific committee, 57 papers were selected by the program committee for oral presentation which were separated into 16 thematic sessions. In addition, 28 posters were presented and discussed in two poster sessions (The conference proceedings can be downloaded from: http://www.forschungsinfo.de/STI2013/download/STI_2013_Proceedings.pdf). This is how an extensive program which was offered to more than 200 participants from 29 countries coming from all 5 continents came about. The conference was opened by a keynote by Dr. Dietrich Nelle from the German Federal Ministry of Education and Research (BMBF) who in a humorous manner discussed the relationship between in-

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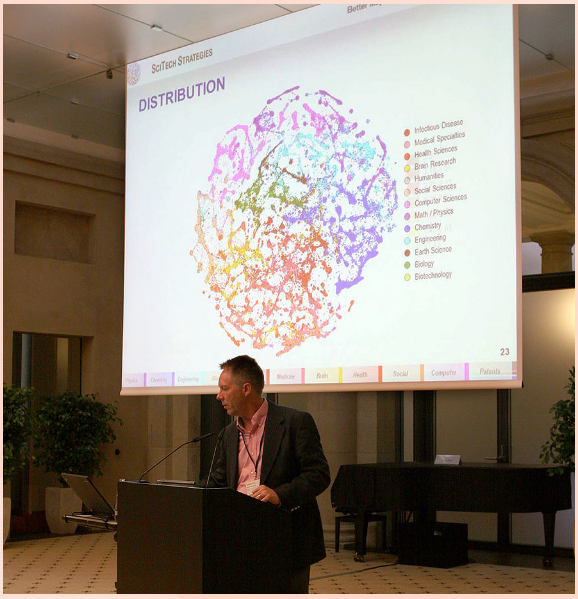
dicator producers and users highlighting the expectations posed to our community specifically from the side of science politics. In the following plenary session Kevin Boyack and Bart van Looy focused in their presentations particularly on methodological approaches to assess and measure how science is translated into application. The discussion of new methodology was taken further in sessions specifically devoted to New Metrics during which new data sources and indicators constructed hereof were introduced. Individual and University Assessments as well as the analysis of Researcher Careers were specifically discussed in the context of the use of STIs. With the sessions on Individual Assessments the STI conference continued a discussion started during this year's ISSI conference in Vienna. This year's STI also aimed at enforcing the discussion on bibliometric standards which started more than 15 years ago at the ISSI conference in Chicago. In a special panel the increased need for setting standards in bibliometrics and fields which specifically call for standardization were discussed as well as options how to initiate respective processes. It is foreseen to continue the discussion started in upcoming events.

Besides exchanging ideas and research results this year's conference also offered opportunities to take a breath and enjoy Berlin at its best. On the first day a guided city walk took us through Berlin's presence and recent history, while on the second day the conference dinner took place – at least partly – on the rooftop of the Berlin Brandenburg Academy of Science and Humanities and offered a great view to one of the most impressive places the city has to offer. The Gendarmenmarkt and the fantastic late summer evening made it all the more enjoyable.

On behalf of the organizers we would like to thank those who contributed to the success of the conference. We hope to see you all at next year's STI conference in Leiden, where the 19th STI conference will take place on September 3-5.



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STI 2014 Leiden

19th International Conference on Science and Technology Indicators

"Context Counts: Pathways to Master Big and Little Data"

The STI/ENID 2014 conference will be held ***3 - 5 September 2014*** *in* ***Leiden, the Netherlands****. The conference will focus on the social science of STI indicators, the context in which indicators function, and the increased availability of data for indicators.*

We specifically invite submissions of research on the following topics:

- New and advanced indicators on measuring science in all its dimensions (including altmetrics)
- Theoretical foundations for measuring research in social science and in information science
- Science policy studies

Hence we welcome contributions on the following topics:

- altmetrics
- author level bibliometrics
- career development
- collaboration
- funding impact assessment
- interdisciplinarity
- networks
- patent analyses
- research evaluation
- research management
- research policy and science management
- science indicators
- science policy
- simulation studies
- societal impact or quality of research
- structuring science
- systemic and behavorial effects of evaluations and indicators
- technology and innovation studies
- theoretical foundations
- university indicators and rankings
- webometrics

Key dates

28 February 2014:
Deadline for submission (papers and posters)

31 March 2014:
Deadline for submission of special sessions

15 June 2014:
Notification of acceptance (papers and sessions)

Submissions

1. Short paper (max 3,000 words) with a comprehensive description of a completed study
2. Research in progress paper (max 1,500 words)
3. Poster (max 1,000 words) with an abstract of the study
4. Special event (details and criteria to be posted on the website)

Contact

http://2014.sticonference.org or **http://sti2014.cwts.nl**
e-mail **sti-2014@cwts.leidenuniv.nl**

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WORKSHOP ON MEASURING SCIENCE: THE SCIENTOMETRIC APPROACH

ORGANISED BY CSIR-NISTADS, NEW DELHI, INDIA

(WORKSHOP COORDINATORS: SUJIT BHATTACHARYA & APARNA BASU)

14 FEBRUARY, 2014

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A National Workshop on "Measuring Science: The Scientometric Approach" was held on 14th February, 2014 at the National Institute of Science Technology and Development Studies (NISTADS), a constituent laboratory of the Council of Scientific and Industrial Research[1]. CSIR-NISTADS is bringing out bi-annually a report on 'Indian Science & Technology' published through Cambridge University Press. Two bi-annual reports have been published so far; Volume 1 (2008-9) and Volume 2 (2010-11), and Volume 3 in print. These reports are first of its kind in India focusing on various dimensions of innovation activity in India; aiming at providing valuable inputs for S&T and Innovation decision making. Assessment of status of Science and Technology through S&T indicators comprise an important part of this report. The workshop was conducted within the ambit of this ongoing bi-annual S&T report series.

The personal visit of Prof Ton (A) F. J. van Raan to India and his acceptance to visit NI-

1 CSIR: a conglomerate of 38 public laboratories in India working in different domains of science and engineering.

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STADS and meet the scientometric community in the country generated huge interest across our research community in the country. Keeping this in context, it was decided that a National Workshop should be held. The workshop was coordinated by Dr. Sujit Bhattacharya (Professor AcSIR and Senior Principal Scientist, CSIR-NISTADS) and Dr. Aparna Basu (Emeritus Scientist CSIR-NISTADS). There were more than 70 scholars/researchers from heterogeneous backgrounds from universities and research institutes who attended this workshop with a large number of the participants being PhD scholars.

Starting with an opening remark on the increasing importance given to Scientometrics in policy studies/decision making in India and the role of NISTADS in strengthening this activity, Dr. Parthasarathi Banerjee (Director, CSIR-NISTADS) opened the floor to Dr. Basu and Dr. Bhattacharya, who introduced the speakers and workshop program. The keynote address was given by distinguished scholar Professor Ton van Raan, Professor of Quantitative Studies of Science at the Centre for Science and Technology Studies (CWTS) (Founder Director of this Center), Leiden University, The Netherlands. Prof. van Raan's talk was titled 'Advanced Bibliometric Methods for Evaluation of Research Groups, ranking and benchmarking of universities'. He began his presentation by showing interesting glimpses of Leiden, the Leiden University and the mission and objectives of the CWTS group. He exposed the audience to some of the indicators developed by the CWTS and how they help to capture more effectively scientific performance. He then drew attention to the varied types of structures/maps that could be derived from bibliometric elements (citations, keywords, etc) using sophisticated scientometrics methods such as co-citation analysis, bibliometric coupling. He demonstrated how these maps became highly useful for understanding the dynamics of science and in policy context. He then elucidated the advanced bibliometric methods for evaluation of research groups, ranking and benchmarking of universities.

Professor van Raan's address was followed by invited talk by Dr. Gangan Prathap, formerly Director CSIR-NISCAIR and presently Outstanding Scientist of CSIR: National Institute for Interdisciplinary Science and Technology (NIIST), on "Principled and Constructive Approaches and h-type Indices". Dr Prathap's presentation highlighted the need for developing

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indicators that can capture quantity-quality dimensions more robustly. He highlighted their EEE (Energy, Exergy, and Entropy) indicator and showed through example the effectiveness of this indicator in ranking performance. This was followed by a presentation by Dr. M.K. Das (Associate Professor, Institute of Informatics and Communications at Delhi University) and Dr. Ashok Jain (Fellow, National Academy of Sciences, and former Director of NISTADS) on "Complexity Measure in Publication Data". The presentation demonstrated the importance of entropy for analysis of time series data though time series publication data. The presentation also showed how long term publication trends for single and multiple authors differ and their dependence on journal. This was followed by a presentation by Dr. Jaideep Ghosh (Ramanjum Fellow of the Department of Science & Technology and CSIR-NISTADS) on "Networking amongst Scientists as Measured by Bibliometric Data". He highlighted his groups work on the analysis of structures and patterns of scientific research collaboration. He explained how agency-structure integration, network percolation and giant cluster formations, were employed in their work, and their implications for scientometric studies and policy context.

Dr. Aparna Basu highlighted key issues that exist in attempts to measure scientific data. She pointed out the various indicators applied for measuring efficiencies in national science and innovation, and explained the need for linking these indicators to theoretical study for more deeper analytical understanding. The final presentation was given by Dr. Sujit Bhattacharya on the "Salient Aspects of Indian Research Activity: A Scientometric Investigation". Keeping in view the overall theme of the workshop on 'Measurement', the presentation began by highlighting the need to incorporate non-linearity and scaling relationship in construction of indicators, showing how the study on capturing the dynamics of Indian research activity has used this insight to develop a more reliable indicator for measuring India's international collaboration. The talk then highlighted how the landscape of global science is changing with international collaboration, involvement of larger number of stakeholders in publishing activity, and emergence of transition economies influencing the landscape. The presentation then highlighted India's research activity in this global scientific landscape.

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Participants took the opportunity during the lunch break to discuss with the speakers the salient aspects of their presentations. The final session of the day was Panel Discussion chaired by Prof Ton van Raan. Prof van Raan started the panel discussion by drawing attention to the CWTS group efforts to develop reliable and robust S&T indicators. He also highlighted how indicators constructed by this group has been incorporated in bibliometric based evaluation studies globally. He drew attention to the new advanced indicators and cartographic techniques developed by this group and their relevance in science studies and evaluation. Setting the stage, Prof van Raan invited discussion on how scientometric based methods/applications is perceived by the research community in India at large. The discussions that followed were not restricted within the strict domains of scientometrics as participants were from diverse disciplinary backgrounds. This heterogeneous participant background led to critical reflexive discussion touching upon issues such as the evaluation of teachers and professors at universities, role of students in evaluation of teachers (whether they should be an integral part of the evaluation procedure or not), the role of fellow-teachers in the evaluation process, the importance of order of authors, in publication, and the differences in university rankings when using different indicators, and to what extent scientometrics can play a role when fences are created by restricting the free-flow of scientific results. There was a general consensus among the participants that scientometrics is now becoming increasingly important as it is getting embedded within the decision making process and also it is indeed helping to reveal the trends in domains/ sub- domains which is useful to the scientific community. Also it was felt that it is equipping the researchers to explore the intellectual terrain of their research field. It was strongly felt that the workshop of this kind should be a regular feature and should not be restricted within the scientometric community as this workshop had done. This, they felt, would help to connect the researchers with the scientometric community, provide a feedback mechanism to improve the bibliometric tools, and also lead to better appreciation of scientometric based analysis.

For PDF of the presentations, please send email to sujit_academic [at] yahoo.com

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COLLNET JOURNAL OF SCIENTOMETRICS AND INFORMATION MANAGEMENT

I. K. RAVICHANDRA RAO
Chief Editor

HILDRUN KRETSCHMER
Editor

We are glad to introduce the *COLLNET Journal of Scientometrics and Information Management* (CJSIM), a half-yearly published journal (ISSN 09737766), founded in 2007. It is published by the Taylor and Francis Group, UK (www.tandfonline.com/tsim) in cooperation with TARU Publications, India (www.tarupublications.com/cjsim.html). Taylor & Francis have to their credit over 1000 journals of international repute in various scientific fields which are widely appreciated for their research content and quality.

Submissions of papers for publication in the *COLLNET Journal of Scientometrics and Information Management* are welcome for both all of the scientists in the field of quantitative and qualitative science studies as well as for COLLNET members.

COLLNET is representing a global interdisciplinary research network on the topic "Collaboration in Science and in Technology" based on webometrics, informetrics, scientometrics, library and information science as well as on qualitative aspects of science of science (www.collnet.de). The focus of this research network is to examine the phenomena of collaboration in science, its effect on productivity, innovation and quality, and the benefits and outcomes accruing to individuals, institutions and nations of collaborative work and co-authorship in science.

SCOPE OF THE JOURNAL THEME:

On account of the diversity of the issues mentioned above it is possible to obtain promising results only against the backdrop of an interdisciplinary approach in the area of quantitative and qualitative science studies: Collaboration and communication in science and in technology,

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science policy, theoretical, methodological and applied aspects, for example:

- Emerging issues in scientometrics / informetrics / webometrics and history
- Theoretical approaches and methodology
- Library and information science
- Science policy and collaboration
- Collaborative bridge between academic research and industry
- Techniques for collaboration studies and visualization
- Quantitative analysis of S&T innovations
- Informetrics laws and distributions, mathematical models of communication or collaboration
- Nature and growth of science and of collaboration in science and its relation with technological output
- Citations, references, impact factors, evaluation
- Social networking

These examples listed above give a broad outline of the scope of the journal theme but do not limit it.

The *COLLNET Journal of Scientometrics and Information Management* provides excellent reading to scientists/researchers in Scientometrics, Information Management and beyond and opens up new vistas of collaborative research on matters of scientific interest and interpretation on a larger scale both on qualitative and quantitative parameters be it in social sciences, arts, culture, every day science with topical mathematical and statistical data analysis/ indicators. Scholars from interdisciplinary research fields vis-a-vis scientometrics will find this journal very informative and encouraging for furthering substantive research. The journal provides chances for scientists from developed and developing countries to facilitate their active participation in international communication through collaborative efforts. Science has an international character that encompasses the entire world and we feel happy at the idea of development of our scientific community into this young and effective discipline of science for its results, their adaptability and applicability in science.

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THE AUTHOR AFFILIATION SYNDROME—DOES IT REALLY MATTER?

OLLE PERSSON

The number of authors per paper is still growing. One might guess that the number of addresses per author in a given paper is also increasing. This can be observed in Web of Science. Since a few years back authors are connected with addresses. I checked the papers in Scientometrics from 2010 to 2013 and found that 30 percent of the authorships were split into two or more affiliations. Then, it seems reasonable to ask if an author based affiliation counting will yield different results compared to the traditional address based fractional counting.

Author based affiliation counting means that the fraction of a paper an author has is distributed over affiliations. First we give each author a fraction (1/n of authors), and if the author has several affiliations that fraction is further split. Suppose a paper has two authors A and B. A has one country affiliation to Sweden, but B has one to Finland and one to Denmark. A correct assignment would be to give Sweden 0.50 and Finland and Denmark 0.25 each. However, if we only know the addresses, Sweden, Denmark and Finland would get 0.33 each.

Let's take a look at our own journal Scientometrics. A set of 985 source items from Scientometrics 2010 to 2013 was downloaded from Web of Science on the 6th of February 2014. The table clearly shows that the calculation methods yield quite similar sum of fractions at the country level among the top ten listed. When duplicate countries in an article are removed there is a tiny change of ranks between Belgium and Netherlands. Somewhat bigger differences might occur at the organization

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level. Some organizations shift ranks, and some enter the top list while others leave.

One more example. If we take 3235 articles from Science between 2009-2012, authorships with two or more affiliations amounts to 45 percent. From the table below the top ten university lists are almost identical, no matter how we count. We can also observe that author address fractions are generally higher, which means that top universities have more authors on a paper than the universities they collaborate with.

I would recommend that you should apply author based affiliation counting if you can, simply because it is a way of controlling for the effects of the affiliation syndrome. More importanly, we should study this problem more closely on a larger set of papers and in fields where multiple author affiliations are much more common.

SCIENTOMETRICS 2010-2013

County	Author address fractions	With duplicates	Address fractions	Without duplicates	Address fractions
Peoples R China	109.7	Peoples R China	105.6	Peoples R China	106.7
USA	104.8	USA	104.9	USA	106.2
Spain	86.9	Spain	85.7	Spain	86.2
Taiwan	74.5	Taiwan	77.7	Taiwan	74.8
Italy	48.2	Italy	48.8	Italy	48.7
Belgium	46.2	Belgium	46.6	Netherlands	45.2
Netherlands	44.5	Netherlands	44.2	Belgium	43.7
South Korea	42.7	South Korea	42.7	South Korea	42.5
UK	36.1	UK	38.8	UK	40.7
Germany	36.3	Germany	35.3	Germany	34.8

Major organization	Author address fractions	With duplicates	Address fractions	Without duplicates	Address fractions
Leiden Univ	19.4	Leiden Univ	19.1	Leiden Univ	19.3
CSIC	17.9	Natl Taiwan Univ	18.5	CSIC	17.2
Katholieke Univ Leuven	17.3	CSIC	17.2	Natl Taiwan Univ	16.3
Natl Taiwan Univ	15.8	Katholieke Univ Leuven	17.0	Katholieke Univ Leuven	14.3
Wuhan Univ	14.6	Wuhan Univ	12.7	Hungarian Acad Sci	13.6
Univ Roma Tor Vergata	14.1	Hungarian Acad Sci	12.5	Wuhan Univ	12.9
Dalian Univ Technol	12.0	Dalian Univ Technol	12.0	Dalian Univ Technol	11.8
Hungarian Acad Sci	11.7	Indiana Univ	9.7	Indiana Univ	9.6
Univ Amsterdam	10.1	Politecn Torino	9.5	Politecn Torino	9.5
Indiana Univ	9.8	Univ Amsterdam	9.5	Univ Amsterdam	9.2

SCIENCE 2009-2012

Major organization	Author address fractions	With duplicates	Address fractions	Without duplicates	Address fractions
Harvard Univ	104.6	Harvard Univ	103.9	Harvard Univ	97.6
MIT	62.0	MIT	58.4	MIT	55.2
Univ Calif Berkeley	57.0	Univ Calif Berkeley	57.9	Univ Calif Berkeley	49.9
Stanford Univ	54.6	Stanford Univ	49.5	Stanford Univ	47.7
CALTECH	50.2	CALTECH	48.1	CALTECH	46.9
Yale Univ	48.0	Yale Univ	46.2	Yale Univ	41.3
Univ Cambridge	40.0	Univ Cambridge	37.0	Univ Cambridge	35.6
Cornell Univ	33.8	Cornell Univ	32.9	Cornell Univ	31.6
Univ Calif San Francisco	33.3	Univ Calif Los Angeles	32.5	Univ Calif San Francisco	29.4
Univ Oxford	33.2	Univ Calif San Francisco	32.4	Univ Washington	29.4

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INFORMATION FLOW BETWEEN WEST AFRICAN TRIPLE HELIX ACTORS

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INTRODUCTION

The role of university, industry and government has been changing for recent decades; university does not only teach and do research but can compete with firms as well, for example as far as call for tends, bids or services are concerned; government does not only set up rules, watch over their respect, collect taxes and fund but can also set up administrative body to do research or participate to firms capital; industry does not only output services, processes and products for the community but can conduct research on its own in order to improve them. Etzkowitz & Leydesdorff (1995) and Leydesdorff & Etzkowitz (2001) elaborated, on this basis, the Triple Helix concept that represents the necessary dynamics between university, industry and government. If research activities exploit existing knowledge and produce new ones, the circulation of knowledge between innovation actors ensures its transformation into innovations. Innovation takes an important place in industrial development, economic growth and wealth production. There is a positive correlation between the levels of research and development activities and the level of absorption capacity and the pool of knowledge that can be exploited (Mueller, 2006). Hence, knowledge flow between actors can indicate a society or region's level of development and self-organization.

Research and innovation can be measured; collaboration for research and innovation too. Leydesdorff (2003) introduces

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mutual information as an indicator of the Triple Helix of relations between university industry and government, based on the notion of entropy borrowed from Shannon (1948) mathematical theory of information. He interpreted it as a measure of the synergy or information flow between innovation actors. Mêgnigbêto (2014) proposed transmission power as the efficiency of the mutual information. The aim of this paper is to measure knowledge flow between innovation actors in West African region1. The research question is: how does information circulate between innovation actors in the West African region?

DATA AND METHODS

The elaboration of the Triple Helix thesis lays on collaboration between university, industry, and government. Of course, collaboration may cover several aspects and not all collaboration yields publications. In this paper however, we focus on research collaboration understood as co-authorship because it entails the tacit transfer of information and knowledge (Olmeda-Gómez et al., 2008). It has become an indicator for scientific collaboration measuring and is widely used in Academia (Abbassi et al., 2012; Bordons & Gomez, 2000; Katz & Martin, 1997; Olmeda-Gómez et al., 2008).

We downloaded West African scientific publications data from Thomson Reuters' Web of Science over a ten-year period (2001-2010). The databases searched were Science Citation Index Expanded (SCI-EXPANDED), Conference Proceedings Citation Index-Science (CPCI-S), Conference Proceedings Citation Index- Social Science & Humanities (CPCI-SSH) and Index Chemicus (IC). The search expression was *cu=benin or cu=cote ivoire or cu=niger or cu=senegal or cu=cape verde or cu=gambia or cu=ghana or cu=nigeria or cu=togo or cu=mali or cu=liberia or cu=sierra leone or cu=guinea or cu=Burkina faso or cu=guinea-bissau*. The 28,380 resulting records were downloaded into a bibliographic database managed with the CDS/ISIS2 software application. Based on Leydesdorff's (2003) method for address assignment, we established a list of words or abbreviations to attribute a label 'university', 'industry' or 'government' to each address. We coded a Pascal CDS/ISIS3 programme that assigned each address to the corresponding label. A record may contain many addresses; therefore, one record may have two or more different labels. The CDS/ISIS programme was also instructed to read the countries' name from the addresses and automatically add the associated two characters ISO codes to the label. Non-West African countries were given unique identifiers ZZ. Therefore, in the inverted file, a university in Benin appears under the label UNIV-BJ, an enterprise in a non-West African country appears under ZZ-INDU. The print service of CDS/ISIS was used to output some data into text file for statistical analyses and entropies computations.

RESULTS

SECTORIAL OUTPUTS AND COLLABORATION DATA

University produced 82.82% of papers, government 41.09%, and industry 1.07%. Research institutions that do not fall under the above categories include NGOs, national or international associations; they account for 3.80%. If data are restricted to West African-based institutions, university produces

1 West Africa, one of the five African regions as determined by the African Union, counts 15 countries: Benin, Burkina Faso, Cote d'Ivoire, Cape Verde, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Nigeria, Niger, Senegal, Sierra Leone and Togo.

2 CDS-ISIS is text database management software developed and distributed by UNESCO (UNESCO, 1989a).

3 CDS/ISIS provides a programming language "designed to develop CDS/ISIS applications requiring functions which are not readily available in the standard package" (UNESCO, 1989b). This programming language enables users to extend functions of the standard package, to make it more robust and in order to meet users' specific needs (Mêgnigbêto, 1998).

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	U	I	G	UI	UG	IG	UIG	Total
2001	780	3	447	1	103	1	0	1,335
2002	884	6	454	0	129	1	0	1,474
2003	925	8	482	3	156	1	0	1,575
2004	1,011	4	463	2	151	0	0	1,631
2005	1,410	6	657	3	252	1	0	2,329
2006	1,507	6	644	4	238	0	2	2,401
2007	2,086	7	735	7	327	1	0	3,163
2008	2,356	10	747	13	400	4	3	3,533
2009	2,756	7	739	11	427	1	1	3,942
2010	2,684	12	926	12	497	2	2	4,135
Total	16,399	69	6,294	56	2,680	12	8	25,518

Table 1. West African scientific output per Triple Helix actor

Country	Total	U	I	G	UI	UG	IG	UIG
Benin	1,335	548	0	668	0	93	0	0
Burkina Faso	1,785	484	1	1,114	0	164	0	0
Cape Verde	52	14	3	26	0	1	0	0
Cote d'Ivoire	1,669	784	1	808	0	144	0	0
Gambia	986	7	0	208	0	5	0	0
Ghana	3,203	1,821	30	1,371	7	393	5	0
Guinea	241	49	3	168	0	11	0	0
Guinea Bissau	225	16	0	185	0	13	0	0
Liberia	49	14	0	26	0	4	0	0
Mali	1,204	517	0	569	0	85	0	0
Niger	586	196	0	304	0	16	0	0
Nigeria	15,569	13,669	101	2,683	53	1339	14	7
Senegal	2,544	1,062	3	1,172	0	180	0	0
Sierra Leone	117	48	2	60	0	8	0	0
Togo	433	225	1	191	0	26	0	0

Table 2. University, industry and government's scientific production and relations per West African Country

67.45% of papers, industry 0.52% and government 26.89%; not classified institutions' share rises to 11.46%. The breakdown of records with West African-based addresses per year and Triple Helix actor and collaboration data are given in Table 1. Annual data show the same trend and confirm that university (U) is the biggest science producer, followed by government (G), then industry (I). Due to the effect of the Boolean operator AND, university and government (UG) produce jointly more than university and industry (UI) on

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the one hand and industry and government (IG) on the other hand; the double Boolean operator makes the joint output of the three sector (UIG) smaller. At national levels however (Table 2), government is the biggest information producer, ahead university and industry in 12 countries; even some countries (Benin, The Gambia, Guinea-Bissau, Liberia, Mali and Niger) have no industrial output. Globally, the industrial sector's output is weak both at regional and national level.

KNOWLEDGE FLOW BETWEEN ACTORS

We used mutual information (Leydesdorff, 2003), effectiveness and transmission power (Mêgnigbêto, 2014) as measurement of knowledge circulation among the Triple Helix actors. The unit of analysis is publications. The regional university-industry-government system data are output in Table 3. The entropy (H_{UIG}) ranges from 1.207 bits in 2009 to its highest value (1.367 bits) in 2003; no trend is depicted over the period. Because 'Other' is ignored in data computation, the system's maximum entropy is $H_{max} = \log_2 7 = 2.807$ bits (cf. Mêgnigbêto, 2014). It comes that, from 2001 to 2010, the West African innovation system produced less than half its capacity; indeed, annual efficiencies (η) are lower than one half, ranging from 43% to 48%. Annual transmissions (T_{UIG}) are negative indicating a synergy among actors; in other words, the system is not centrally controlled; however the interactions between actors are too low and cannot ensure better circulation of knowledge. As an illustration, transmission varies from -13 to -32 millibits; and, as a consequence, transmission power (τ) ranges from 0.026 to 0.057 which means that 3 to 6% of the system's information sharing capacity was really used. In other words, much information doesn't circulate among innovation actors in West Africa. Synchronous data (Table 3, Row Total) reveals that the West African innovations system products 1.301 bits of information representing 46% of its capacity; the synergy is evaluated to -19 millibits, that is 4% of the information sharing capacity.

The comparison of bilateral transmissions shows that whatever the year is, the entropy of university-government system (H_{UG}) is higher than that of university-industry system (H_{UI}) which in turn is higher than that of industry-government system (H_{IG}); the system's entropy (H_{UIG}) is the highest (Figure 1). According to Leydesdorff (2003), the three-dimensional system's entropy and transmission formulas are:

$$H_{UIG} = H_U + H_I + H_G - T_{UI} - T_{UG} - T_{IG} + T_{UIG} \quad (1)$$

and

$$T_{UIG} = H_U + H_I + H_G - H_{UI} - H_{IG} - H_{UG} + H_{UIG} \quad (2)$$

Entropy measures uncertainty; when the transmission (T_{UIG}) is negative, it contributes to the reduction of the uncertainty that prevails at the system level (Leydesdorff, 2003). In Equation (2), the left term groups entropies, thus positive values; however, bilateral entropies are affected with the negative sign; therefore, the higher they are, the more negative the transmission. In other words, bilateral entropies contribute to the reduction of the uncertainty at the system level. In the case of the West African innovation system, $H_{UG} > H_{UI} > H_{IG}$ over 2001-2010 (Figure 1); we conclude that at the tri-lateral system level, the university-government relations contribute more to the uncertainty reduction than the other two bilateral systems.

At national levels, because industrial output is null in some countries, H_{UI} and H_U on the one hand and H_{IG} and H_G on the other hand are equal; therefore, the transmission between the industrial sector and the two others are null as far as these countries are concerned. In the remaining countries, T_{UI} and T_{IG} are weak (0.1 to 10 millibits). Whatever the country is, H_{UG} is greater than H_{UI} and H_{IG}, T_{UG} than T_{UI} and T_{IG}. The national system with the highest entropy is the Sierra Leonean (H_{UIG} = 1.387

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	H_{UI}	H_{UG}	H_{IG}	T_{UI}	T_{UG}	T_{IG}	H_{UIG}	T_{UIG}	η	τ
2001	0.956	1.286	1.013	0.002	0.615	0.001	1.302	- 0.017	0.464	0.026
2002	0.932	1.306	1.011	0.008	0.559	0.001	1.313	- 0.027	0.468	0.046
2003	0.955	1.342	1.036	0.004	0.528	0.003	1.367	- 0.032	0.487	0.057
2004	0.897	1.282	0.988	0.002	0.538	0.003	1.294	- 0.018	0.461	0.032
2005	0.900	1.322	1.004	0.002	0.506	0.001	1.340	- 0.018	0.477	0.035
2006	0.887	1.283	0.994	0.001	0.508	0.001	1.307	- 0.020	0.466	0.038
2007	0.828	1.242	0.963	0.001	0.466	0.001	1.267	- 0.016	0.451	0.032
2008	0.820	1.243	0.982	0.002	0.420	0.000	1.293	- 0.018	0.461	0.041
2009	0.746	1.175	0.922	0.001	0.402	0.001	1.207	- 0.013	0.430	0.030
2010	0.830	1.279	0.987	0.002	0.424	0.001	1.315	- 0.019	0.468	0.043
Total	0.860	1.272	0.986	0.002	0.476	0.001	1.301	- 0.019	0.463	0.038

Table 3. Mutual information, effectiveness and transmission power in the West African innovation system

Country	H_{UI}	H_{UG}	H_{IG}	T_{UI}	T_{UG}	T_{IG}	H_{UIG}	T_{UIG}	η	τ
Benin	1.000	1.292	0.981	0.000	0.688	0.000	1.292	0.000	0.460	0.000
Burkina Faso	0.955	1.255	0.855	0.000	0.542	0.001	1.255	- 0.006	0.447	0.010
Cape Verde	1.242	1.362	1.222	0.043	0.526	0.099	1.362	- 0.217	0.485	0.245
Cote d'Ivoire	1.003	1.336	1.000	0.001	0.654	0.001	1.336	- 0.006	0.476	0.009
Gambia	0.305	0.359	0.203	0.000	0.150	0.000	0.359	0.000	0.128	0.000
Ghana	1.047	1.433	1.085	0.007	0.530	0.005	1.465	- 0.047	0.522	0.080
Guinea	0.921	1.099	0.841	0.006	0.497	0.028	1.099	- 0.066	0.392	0.111
Guinea Bissau	0.572	0.707	0.383	0.000	0.249	0.000	0.707	0.000	0.252	0.000
Liberia	0.976	1.289	0.902	0.000	0.590	0.000	1.289	0.000	0.459	0.000
Mali	0.999	1.301	0.990	0.000	0.688	0.000	1.301	0.000	0.464	0.000
Niger	0.977	1.136	0.958	0.000	0.799	0.000	1.136	0.000	0.404	0.000
Nigeria	0.696	1.027	0.850	0.009	0.370	0.001	1.066	- 0.031	0.380	0.076
Senegal	1.012	1.319	1.002	0.001	0.671	0.001	1.319	- 0.011	0.470	0.016
Sierra Leone	1.106	1.387	1.086	0.016	0.594	0.021	1.387	- 0.087	0.494	0.121
Togo	1.008	1.280	1.021	0.003	0.707	0.002	1.280	- 0.018	0.456	0.025

Table 4. Mutual information, effectiveness, and transmission power in the West African national innovation systems

bits) and that with the lowest value is the Gambian (H_{UIG} = 0.359 bits). Cape Verde has the highest transmission (T_{UIG} = -217 millibits) and the six countries with 0 output for industrial sector has a null transmission. Gambia has however the less efficient system (η = 12.8%) and Ghana the most efficient one (η = 0.552). Out of the nine countries with a non-null transmission, Cape Verde has the highest transmission power ($\tau = \tau_1$ = 0.245) and Burkina Faso the lowest ($\tau = \tau_1$ = 0.010).

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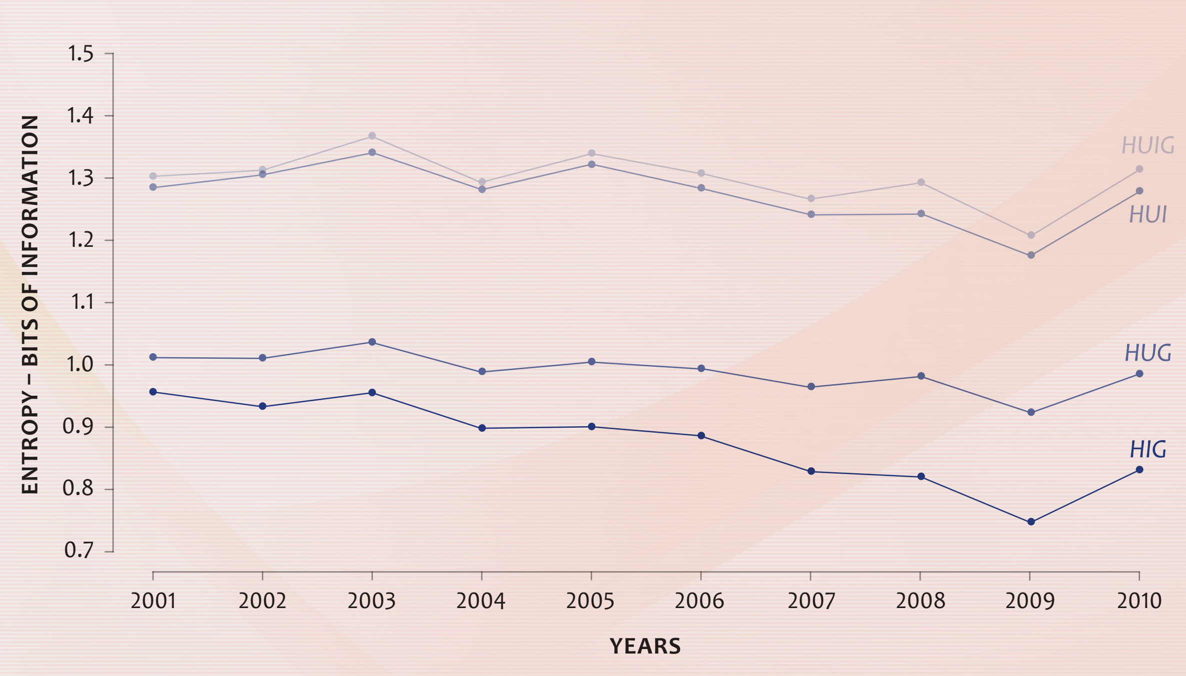

Figure 1. Relative positions of H_{UI}, H_{UG}, H_{IG} and H_{UIG} (2001-2010)

DISCUSSION AND CONCLUSION

Among the 15 West African Member States, six has no industrial output; over the remaining, two (Ghana and Nigeria) exhibit relationships between industry and government on the one hand and industry and university on the other hand; but the joint collaboration between the three actors occurs only in Nigeria. This results show that there is no tradition in research collaboration grouping together industry and other actors. Indeed, the West African industrial sector is facing a number of problems that make less than half its capacity is really used (ECOWAS Commission, 2010; Mêgnigbêto, in press). The numerous untapped underground and mineral resources the region is endowed with are exported rather than processed locally (ECOWAS Commission, 2010), so final products are mainly conceived out of Africa and not for African. As a consequence, local industry doesn't need research activities to improve products, processes or services.

In the countries with null industrial output, the bilateral transmissions T_{UI} and T_{IG} are null; further, the trilateral transmission T_{UIG} is null. These results suggest that regarding research output, there is no knowledge transfer between industrial sector and the two others on the one hand and one the other hand, there is no information transfer between the three actors. Only Nigeria and Ghana show industrial collaboration with U and G sectors; but Ghana has no UIG relations; these two countries have the higher industrial contribution to GDP; on its own, Nigeria counts one half of the region industries and contributed 40% of the regional GDP in 2006 (ECOWAS Commission, 2010, p. 17), that means industrial activities are better developed in the country than elsewhere.

It is expected that university is ranked first with respect to scientific output, because of the flow of doctoral students and publishing activities of scholars. At national level, except Ghana, Nigeria and Togo, university output is less than governmental one, certainly because hospital which is also the affiliation of some scholars, are categorized into governmental body. However, Nigeria on its own produces half the regional output and its university share is the largest compared with others countries; as a consequence, the regional output is balanced in favor of university. The ranking of countries with respect of transmission and transmission power yields the same result, leaving at the rear the

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six countries with null industrial output. In comparison with other countries (Mêgnigbêto, 2014, pp. 288–289), taking into account a ten-year period, West Africa performs less than individual countries like USA, UK, Germany, France, Russia, India, Brazil, China and Korea for their one-year data.

This paper uses publication as unit of analysis and compute collaboration between university, industry and government from data collected at international level. We should stress that not all collaboration yield publications and not only research is field for collaboration between actors.

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GROWING H-INDEX FOR SOME PRICE MEDALISTS

OLLE PERSSON

WOLFGANG GLÄNZEL

INTRODUCTION

In some previous reports by Glänzel and Persson (2005) and Bar-Ilan (2006) the attempt was made to apply the – at that time new-fledged h-index – to selected authors who have been proven to be successful in the field of scientometrics and informetrics. The first study by Glänzel and Persson, based on data retrieved and extracted from Thomson Reuters Web of science, was repeated by Judit Barl-Ilan using data from Google Scholar. She concluded that ”computations of the h-index based on Google Scholar give similar values compared with the ISI-based computations”.

The initial enthusiasm for this indicators was soon chilled and made way for scepticism. In a special session on individual level bibliometrics organised at the 14th ISSI Conference held in Vienna in 2013, Glänzel and Wouters formulated 20 recommendations for bibliometrics (“The dos and don’ts in individual-level bibliometrics”). In particular, Glänzel and Wouters (2013) recommended to use bibliometrics at this level on the basis of individual researchers profiles and combining bibliometrics with qualitative information about careers and working contexts. This is all the more important since scientists proved to become increasingly mobile and integrated in research teams of stable or changing constitution (Glänzel, 2014). Hirsch (2010) has recognised the role of co-authors and their influence on the col-

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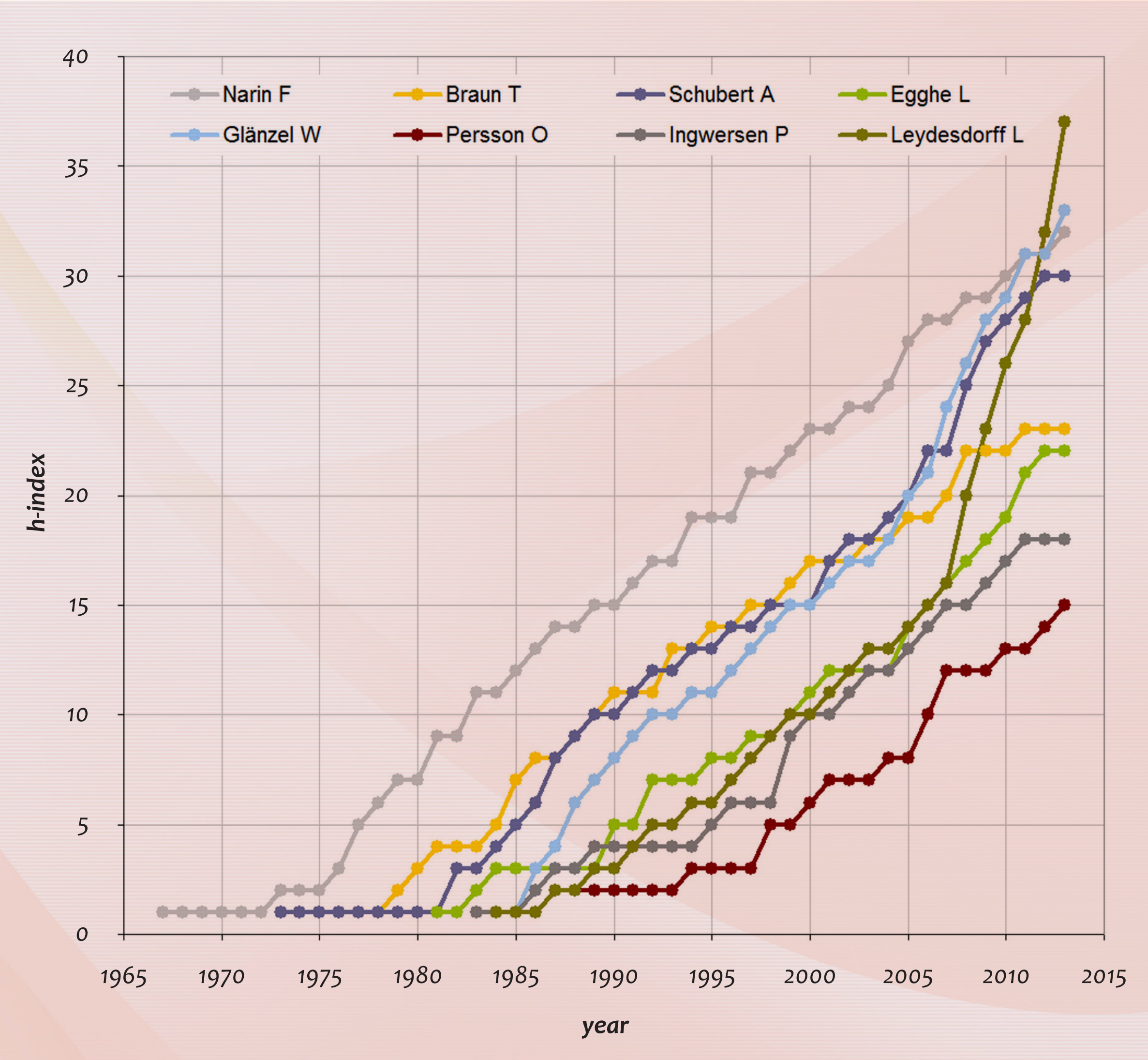

Figure 1. h-index growth of eight selected and still active Price Awardees

laborators' h-index. This has prompted him to propose a new measure called ħ (h-bar) to characterise the scientific output of a researcher that takes into account the effect of multiple co-authorship.

During the last five years several studies have been published on the application bibliometrics to career analysis of individual scientists. Liu and Rousseau (2008) and Egghe (2009) were among the firsts to systematically analyse real h-index sequences of a scientist's career. The growth dynamics in such h-index sequences was studied by Wu et al. (2011); they distinguished five specific and paradigmatic shapes including, linear, convex, concave, S-shaped and IS-shaped curves. Besides this classification, they also investigated the constitution of the *h-core* of an individual scientist to capture its "freshness". This is a strong indicator of the topicality of an author's highly cited papers. Guns and Rousseau (2009) presented a simulation of different basic shapes of h-index growth, which was otherwise predicted by Hirsch (2005) to be linear. Zhang and Glänzel (2012), finally, used h-index sequences and the mean age sequence of the h-core along with demographic tools to characterise individual scientists' research output. In what follows we will take up the latter approaches and combine these with the idea of analysing the research output of Price Awardees. To do so, we proceed from Thomson Reuters Web of Science database again.

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METHOD

As has been done in the note by Glänzel and Persson (2005), we apply an author search in the Web of Science, and then make a Citation Report which is saved in Excel format. A simple data processing guarantees that invalid records are discarded: We scanned the list of publications and deleted those rows that did not include the relevant author or publications, e.g., merely chemistry-related papers by Tibor Braun. Ocassional non-bibliometrics papers such as mathematics (Egghe and Glänzel) or chemistry (Schubert) have little effect, if any, on their h-index sequence.

Now we copied the part of the matrix that starts with the first citing year and save it as a tabbed text-file. One could also paste the matrix to "The List" in BibExcel (Persson, 2014) and then run *File/Save The list to a file*. Then run *Analyze/h-index growth, a preparatory step* in BibExcel. Next, select the cxx-file and run *Analyze/h-index*. Then open the hdx-file in Excel to make the h-index by year graph. Of course, complete manual processing after downloading the Citation Reports yields the same results but the way to those might be longer and a bit more painful: *Per aspera ad astra …*

RESULTS AND DISCUSSION

As expected, individual research careers do differ. The oldest who are no longer active are slowly growing and have several plateaus for some years. Therefore we have selected eight still active Price awardees for the analysis. Narin is still active and has a linear growth without plateaus. Then we have a group of awardees that started during the first half of the 1980s. Three of them grow in a noteworthy fashion, Schubert, Glänzel and especially Leydesdorff. Ingwersen and Persson have a linear and slower growth. All results are shown in Figure 1.

Despite the above-mentioned differences and peculiarities, which are mainly reflecting a sudden increase of the h-index of Schubert, Leydesdorff and Glänzel after 2005, the most striking property refers to a common feature: except for a certain phase shift due to the respective date, when the individual career started up, the overall linear growth generally reflects similar.

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NOBEL PRIZE WINNER PUBLISHES IN ISSI PROCEEDINGS

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My brother, Michael Levitt, nowadays working at the department of structural biology of the Stanford University School of Medicine (CA, USA) was awarded the 2013 Nobel Prize for Chemistry. More precisely, he was honoured for the development of multiscale models for complex chemical systems. His enthusiasm for research contributed to my desire to do research in mathematics. However, because of deteriorating eye sight, I was not able to complete my Ph.D. in mathematics, and I then jointly started and was deputy principal of a school for intelligent children not achieving to their potential. In the 1990's Michael introduced me to the 'C' computer programming language and after working with him on a programming task for more than a year, I worked as a software engineer and then a tutor in computer programming. I resumed research when journal articles became available in electronic format, and whilst a doctoral student often discussed my informetric research with Michael. These discussions occurred, not only by phone and email, but also during his frequent visits to London. They encompassed both my doctoral research and general scientometric topics, such as the importance of field normalisation and the limitations of the h-index.

Soon after I completed my Ph.D. with Mike Thelwall, at the University of Wolverhampton, in autumn 2008 Michael gave me some very helpful feedback on my application for an ESRC (Economic and Social Research Council) post-doctoral fellowship on citation analysis. In the summer of 2010, during my ESRC fellowship, Michael began corresponding with me on the quantitative

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Michael Levitt receiving his Nobel Prize at the Stockholm Concert Hall, 10 December 2013. Copyright © Nobel Media AB 2013. Photo: Alexander Mahmoud.

evaluation of research. He had been asked to participate in the evaluation of medical research at Cambridge and wanted my advice. I advised Michael on citation analysis, such as the importance of comparing articles in the same year of publication and that different disciplines have very different levels of citation. Before the evaluation, Michael spent a few days with me in London and we had extensive discussions on research evaluation. One of our discussions focused on the following ways for allocating author credit: (a) weight of paper is n and each author gets 1 credit per paper (whole counting system), (b) weight of paper is 1 and each author gets 1/n credit per paper (fractional counting system), and (c) weight of paper is sqrt(n) and each author gets 1/sqrt(n) credit per paper . We agreed that the contribution of authors, with different levels of collaboration, is affected by the way in which author credit is allocated.

Following on from the realisation that the research contribution of authors depends on the way in which author credit is allocated, I began investigating the contributions of authors in physics. I chose physics, as it enables contributions to be examined for very high levels of authorship (some physics articles have hundreds of authors). After receiving regular feedback from both Mike Thelwall and Michael, I submitted a proposal for the ISSI conference in Durban, South Africa. This research, on contribution in physics, was presented in July 2011 (Levitt et al., 2011) and a more detailed analysis published in the autumn 2011 ISSI Newsletter (Levitt, 2011). An investigation of contributions in information science that uses a more refined method was presented at ISSI 2013 in Vienna (Levitt & Thelwall, 2013) and I am currently preparing an article that applies the refined method to examine contributions in multiple disciplines.

My brother's influence on my research extends beyond the research on this particular contribution. In 2010, Michael showed me a computer program which he had written to automatically analyse downloaded

*Michael Levitt, 2013 Nobel Laureate in Chemistry
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Web of Science records. He gave me his code, urged me to use computer programing to analyse my scientometric research and from autumn 2010 onwards I have used programming in my data analysis. Automation of data analysis has enabled me to conduct more intricate investigations and readily extend studies to multiple disciplines and years of publication.

This story brings me to the introduction of a new type of Erdös number. It is well-known that a scientist's Erdös number is defined as the smallest distance in the collaboration graph, of this scientist to the famous mathematician P. Erdös (Glänzel & Rousseau, 2005). Similarly one can define any famous (or not so famous) scientist's number. For instance, I have a Michael Levitt number equal to 1 and so does Mike Thelwall. These numbers are collaboration-based numbers. Instead of considering collaboration links one may consider the graph in which nodes (scientists) are linked if they have published in the same journal/journal issue/proceedings as famous scientist X. We may call this a co-publication X number (i.e. a poor man's Erdös or X number). In this way the 250 (give or take a few) contributors of the Durban ISSI proceedings all have a proceedings co-publication Michael Levitt number equal to one.

As a final note I would like to point out that our Durban ISSI conference article has not (yet) been cited in the Web of Science.

ACKNOWLEDGEMENTS:

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