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## EDITORIAL

### ISSI: 2007—2015

In 2007, before the 11<sup>th</sup> ISSI conference in Madrid I became the second elected president of the society, succeeding Henry Small. In 2011 I was re-elected. Now, a few weeks before the 15<sup>th</sup> conference in Istanbul, my term as president of the society ends. As such it is a good time to look back and see what happened in our field during these past eight years.

I think that this period can be characterized by two main events: the foundation of a very successful new journal in our field, namely the Journal of Informetrics (JOI). Thanks to its editor in chief, Leo Egghe, its publisher, Elsevier, the journal's reviewers and not in the least its authors, this journal has become the most visible metrics, specialty journal. The second main event is the rise of a new branch on the informetrics tree, namely altmetrics. Taking into account the influence of research on the public at large, is indeed a major new event.

Of course other developments should be mentioned: the DORA declaration, the Leiden Manifesto, the rise in influence of university rankings, the OA movement, with the series of PLOS journals and PeerJ on the one hand and the flood of predatory journals on the other, the influence of big data and the ever increasing number of metrics-related publications. Volume 102(1) of *Scientometrics* counted more than 1000 pages.

As for the society we have had successful conferences in Madrid (ESP), Rio de Janeiro (BRA), Durban (ZAF), Vienna (AUT) and Istanbul (TUR). I would like to express my warm thanks to organizers, chairs, reviewers and participants: without their contributions there would not be a society.

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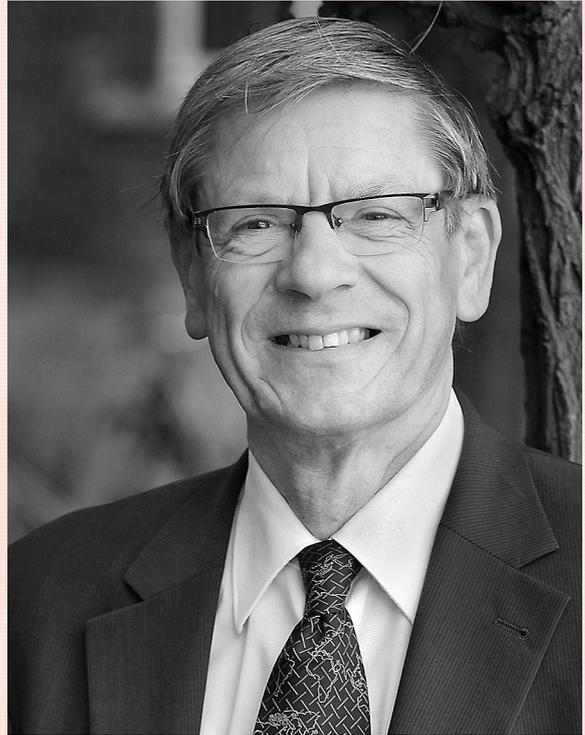


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Maybe this is also the moment to recall some of my own contributions. During, and before, the ISSI conferences I played some role, be it mostly behind the scenes. I took care of the organization of the Eugene Garfield Doctoral Dissertation award (usually leaving the practical discussions to Birger Larsen), proposed to move from biennial to yearly conferences (but was not followed in this by the board), proposed to allow at most two terms for the society's president, and generally acted as a point of reference for all those who contacted the society (with great help of Wolfgang Glänzel). Returning to the restriction on the duration of a presidency, I think that long leaderships by the same person lead at best to stagnation and at worst to situations as in the International Football Association (FIFA). That said, I think that some continuation is a good thing and see no gain in, for instance, yearly presidential elections as is the rule in ASIS&T.

During the period of my presidency I addressed the members mainly through the Newsletters. Besides 'research' contributions I want to recall the following contributions published in the ISSI Newsletter: The role of our society in the organization of the international conferences on scientometrics and informetrics (in issue 15), a Board Meeting News item after the Brazilian conference (issue 23), in which I announced closer collaboration with ASIS&T and a joint pre-conference symposium to be held (and actually held) in Vancouver (November 2009). A report on his symposium was published in issue 24. In issue 33, together with Siladitya Jana I wrote an obituary to remember our Indian colleague Subir K. Sen, best known for his work on relative bibliographic coupling. With Wolfgang Glänzel I recalled the Guidelines for bidding for forthcoming ISSI conferences (issue 34).

Finally, I would like to thank Eugene Garfield, for supporting the young members of the society, the members of the board (Subbiah Arunachalam, Judit Bar-Ilan, Aparna Basu, Kevin Boyack, Peter Ingwersen, Vincent Larivière, Jacqueline Leta, Grant Lewison, Martin Meyer, Henk Moed, Ed Noyons, Olle Persson, Cassidy Sugimoto) for their positive



*Once upon a time – it actually was 1986 – Leo Egghe said to me: “Shouldn't we start a biennial international conference on informetrics?”*

*“Yeah!”, I answered, “and maybe in 2015 we'll arrive in Istanbul.” So, the wheels started turning and the first conference was organized in 1987. Other conferences followed, but soon we ran into a 'structural' problem, which was solved by creating ISSI, the International Society for Scientometrics and Informetrics.*

*The society and conferences were very successful and we visited every continent; actually almost every continent as the penguins declined our invitation. For this reason there is still a blind spot on Kathy Börner's map of places and regions visited by our conferences.*

*Then, around that time, the International Olympic Committee had a Belgian president, and also Europe had a Belgian president, hence the society also needed a Belgian president. So that is how I became the president of ISSI.*

*But all things come to an end (although this may not hold for a certain eternal city that, in four years will be the center of the informetric world), and following the other two Belgian presidents, I too resigned.*

*Now all that's left to me is wishing you all a fruitful informetric career, keeping Kevin Boyack's motto in mind: “Seek to bless, not to impress”. Hopefully this wish will be realized with some help of the society, its board and Cassidy Sugimoto, the new president.*

attitude and help, and especially the society's secretary, Wolfgang Glänzel, the heart and soul of ISSI. I wish my successor Cassidy Sugimoto a pleasant and dynamic presidency.

*Ronald Rousseau,  
former president of the ISSI*

# RESULTS OF THE ISSI 2015 ELECTIONS

A REPORT BY BALÁZS SCHLEMMER, ELECTION ASSISTANT

**In the last issue of the Newsletter (#41) we reported about the nomination turn of the ISSI 2015 Elections. Now we continue the report with the outcome of the voting turn, that is, with the final results of the ISSI 2015 Elections.**

ISSI renews its board regularly. The president, as well as the board members are elected for 4 years, however, due to different inauguration years, the board is partially renewed in every two years. In 2015 the president's (Ronald Rousseau) and 2 board members' (Henk Moed and Ed Noyons) mandates expired.

## THE VOTING TURN

A candidate's eligibility was based on two conditions: 1) being nominated by at least one member in the course of the first turn of the election procedure, and 2) acceptance of nomination. Those who did not reply (in time) were considered as nominees not accepting the nomination. [Remark: as the first deadline seemed to be too short, a second circular was sent out to the nominees with an extended deadline for feedback. Although this deadline extension brought a few more acceptances, indeed,

they all referred to board membership only.] After the second (extended) feedback time expired on 30 April, the actual voting was carried out online.

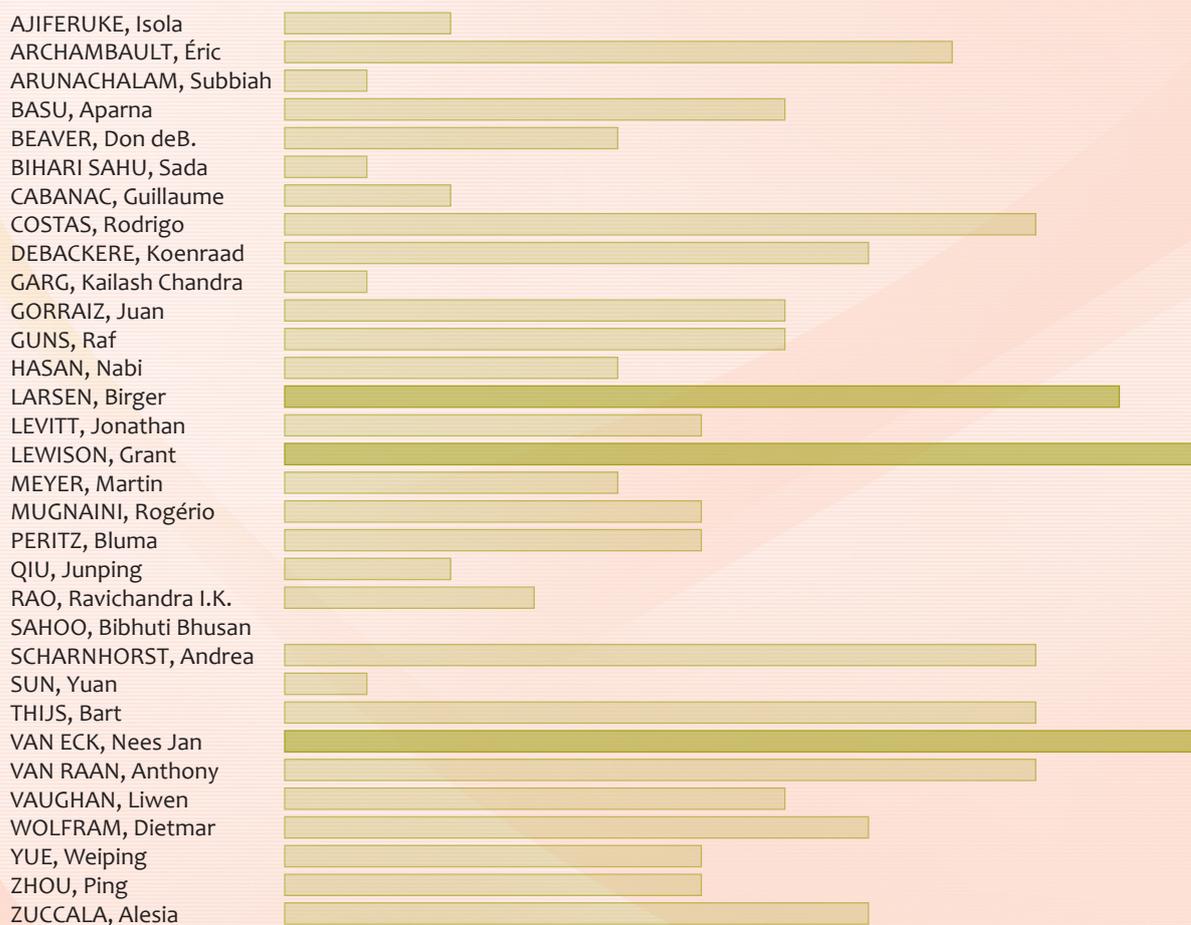
In order to filter out unauthorised and/or repeated voting, members had to log in with their ISSI accounts, but the voting, similarly to the nomination, was anonymous. 61 valid ballots arrived to the ISSI until 15 May, when the election was officially closed. No repeated or incorrect vote was encountered in the course of summing the results. Two ballots arrived after the deadline: in accordance with the election rules, they were not taken into account.

The 61 valid +2 invalid ballots represent roughly 40% of the members having the right to vote.

On the basis of IP addresses (which, in certain cases, might be, of course, misleading) it seems that the votes arrived from no less but 5 continents' 22 countries (whereas ISSI currently has members from 37 countries all over the world).

## RESULTS: PRESIDENCY

As remarked earlier, the nomination turn had a few surprises. One of them was that out of 22 president candidates only 4 accept-



ISSI 2015 Elections: Vote distribution for Board Membership

ed the nomination and ran for presidency. (The question of why this position turned out to be so unappealing would require a major analysis, because if this tendency continues, ISSI will remain without any president candidate at the next election...)

Because of the low number of president candidates it might have happened easily that the distribution of votes would become very uneven, that is, the votes of some of the candidates would run away on the expense of the others'. But in fact, a very balanced rivalry could have been witnessed: all four candidates got at least 10 votes and for quite a long time it was rather unpredictable which one of them would end up in the first place. The final rank yielded Cassidy Sugimoto as the next ISSI president:

<b>Cassidy Sugimoto (USA):</b>	<b>29.83%</b>
Éric Archambault (CAN):	28.07%
Ravichandra I.K.Rao (IND):	24.56%
Koenraad Debackere (BEL):	17.54%

## RESULTS: BOARD MEMBERS

Under normal circumstances it would have been only Henk Moed's and Ed Noyons's vacant positions to vote about but Cassidy Sugimoto's promotion for presidency (see above) made it necessary to fill her board member position as well. For this reason, the top 3 candidates were selected from the final rank. It was Grant Lewison (GBR), Nees Jan van Eck (NLD) and Birger Larsen (DNK) who received the most votes from the members. Consequently, they are the new members of the renewed board.

There is nothing else left but to congratulate to the newly elected president and board members, as well as to say thanks to those stepping down, and to all those ISSI members who helped carrying out the 2015 Elections by nominating, voting and/or being a nominee. Thanks and see you in 2017!

# AESIS

NETWORK FOR THE  
ASSESSMENT & EVALUATION OF THE SOCIETAL IMPACT OF SCIENCE

## THE LAUNCH OF A NEW INTERNATIONAL NETWORK ON SCIENCE IMPACT ASSESSMENT

IMPRESSION OF THE LAUNCH MEETING OF AESIS  
5 JUNE 2015, AMSTERDAM

Photo: © ScienceWorks



*'The AESIS network creates an excellent opportunity to accelerate the learning curve on measuring impact of science.'*

*(Robert Tijssen, CWTS/U-Multirank)*

On 5 June 2015, the AESIS Network was launched, immediately after the conference [Impact of Science](#). Two important outcomes of the conference were:

1. There needs to be an extension from assessing research impact in a retrospective manner to also assessing research impact in a prospective manner.
2. A clear insight of the responsibilities of science funders, research management and the individual researcher will support the process of assessing research impacts.

## AESIS NETWORK

The network connects different groups of stakeholders in assessing and evaluating the impact of science:

- ▶ Research managers who have to demonstrate societal impact;
- ▶ Science assessment experts who process data and analyse instruments for this;
- ▶ Science funders/policy makers who have to evaluate this societal impact.

The importance of merging weakly connected pools of experience and expertise follows from our conviction that the professionalisation in demonstrating the diverse impacts of science will, eventually, substantiate and support investments in public research.

## ACTIVITIES OF THE AESIS NETWORK

The AESIS Network will create a platform to share experiences, ideas and best practices regarding measuring, demonstrating and assessing the societal impact of science. International exchange of best practices is stimulated through the annual conference Impact of Science and through regional activities with a specific focus. Annually two trainings will be organized. The first regional event will be a 3-day international course for science funding experts and research programme designers on **9-11 December, in London**.

Besides activities directly related to the mission, the Network will collect and distribute relevant publications, discussions

and opinions through several newsletters per year. Best practices, examples and case studies can provide a benchmark for research evaluations to demonstrate the societal impact of science.

In the future, the AESIS Network will award an 'Impact of Science award'.

## THE ADVISORY BOARD

The Network is steered by an [Advisory Board](#), with experts representing the different segments of the targeted membership. Advisory Board members are:

- ▶ **KOENRAAD DEBACKERE** (Chair), General Manager at K.U. Leuven, Belgium
- ▶ **ALISON CAMPBELL OBE**, Director of Knowledge Transfer Ireland at Enterprise Ireland
- ▶ **LUKE GEORGHIOU**, Vice President for Research and Innovation and Professor of Science and Technology Policy at the University of Manchester, United Kingdom
- ▶ **BAREND VAN DER MEULEN**, Head of Science System Assessment at Rathenau Institute, Netherlands
- ▶ **SUSAN RENOE**, Director of the Broad-er Impacts Network, United States
- ▶ **TOBY SMITH**, Vice President of Policy at the American Association of Universities
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## THE LAUNCH

At the launch, the Advisory Board of AESIS was introduced, and the future activities of the Network were discussed. To accomplish the goals, a change in culture is important. It is important to collect best practices, examples and case studies on how to work with researchers, in order to promote a constructive environment for

assessing and evaluating the societal impact of science. The possibility of an 'Impact of Science award' was discussed. The necessity to include active researchers and policy makers was acknowledged by the Advisory Board members. Aesis would like to contribute to the international exchange of best practices as much as feasible.

## MEMBERSHIP

Both individuals and organisations can become a member of the AESIS Network. Join the Network before 1 July, and become one of its founding members for free until 2016!

As a member, you will be able to submit content to the Network newsletter, and get priority registration at a reduced participation fee in Network events. Please register through our website. Regular membership is €125 and the academic fee is €75.

# THEORIES OF INFORMETRICS AND SCHOLARLY COMMUNICATION

## A FESTSCHRIFT IN HONOR OF BLAISE CRONIN

EDITED BY CASSIDY R. SUGIMOTO  
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In 1981, then doctoral student Blaise Cronin published “The need for a theory of citing”—a call to arms for the fledgling scientometric community to produce foundational theories upon which the work of the field could be based. More than three decades later, the time has come to answer this call. The chapters in this Festschrift—compiled on the occasion of Blaise Cronin’s retirement—describe, extend, and propose several theories of informetrics and scholarly communication.

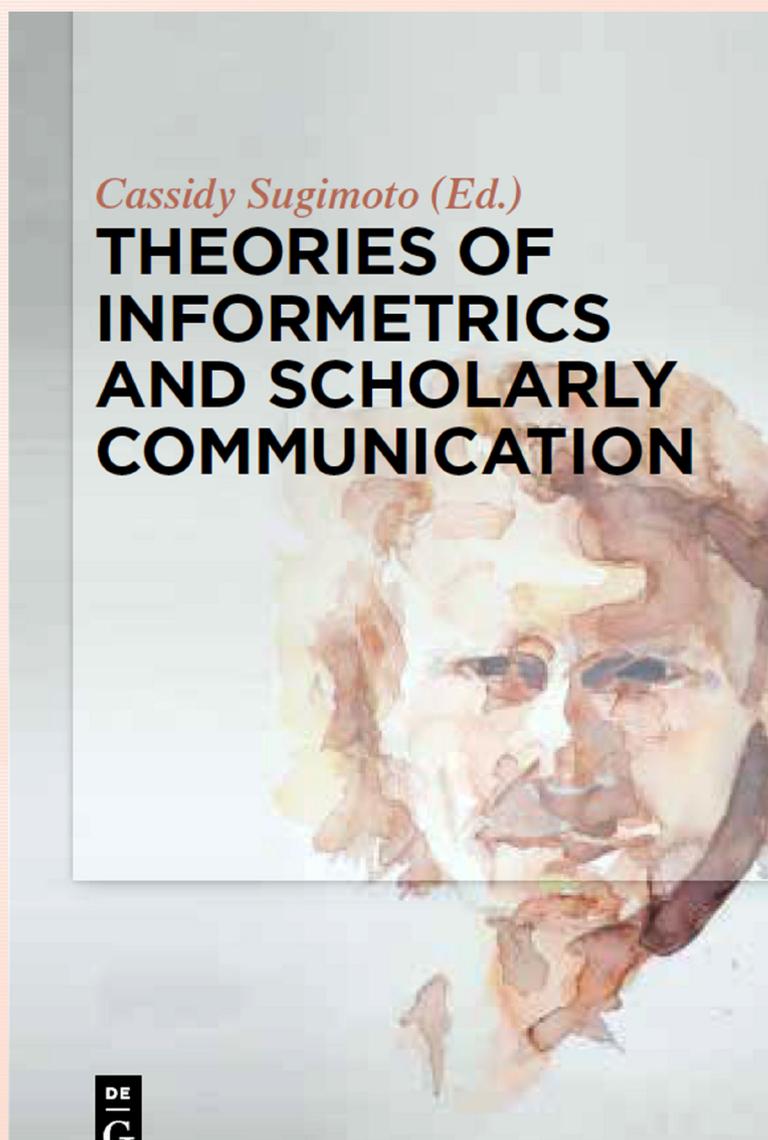
Metrics have become deeply integrated into the conduct and evaluation of modern science in the form of personal assessments and national-level assessment exercises. This has brought scientometrics into the limelight in a way that makes a theoretical

compilation critical. Furthermore, the rapid proliferation of new metrics makes necessary documentation of theories that can be used to guide the implementation and interpretation of metrics—whether traditional references or alternative ones.

This Festschrift provides a much-needed theoretical foundation for the field, examining citation theories, author theories, statistical theories, knowledge organization theories, and altmetric theories and advocates for a shift towards critical informetrics. These themes ground the work in the historical literature of informetrics while simultaneously addressing the dynamic needs of the contemporary scholarly communication landscape.

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BIOGRAPHICAL INFORMATION FOR THE  
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# CHARACTERISTICS OF INTERNATIONAL COLLABORATION IN SPORT SCIENCES PUBLICATIONS AND ITS INFLUENCE ON CITATION IMPACT



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## ABSTRACT

**Background:** Some bibliometric research has been carried out in sport sciences, but compared with other disciplines there is still no intensive study at macro level, especially on international collaboration.

**Aim:** This study attempts to observe the status and trend of international collaboration in sport sciences at macro level, and to look at its relationship with academic impact.

**Methods:** 20804 publications from 63 consistently issued journals belonging to the Sport Sciences category in Web of Science database in 2000–2001 & 2010–2011 were analyzed. The main objects include co-authorship links of country pairs, the share of international co-authored publications, tendency and “affinity” in collaboration, and citation impact of international publications. Differences between countries and periods were observed.

**Results:** There is a rapid increase of the share of international collaboration in sport sciences. In some countries the share is even above 2/3; Co-authorship networks imply some cultural, political or geographical factors for collaboration, and their changes exhibit some new trends; Selected countries have strong tendency in collaboration; International collaborated publications have a higher performance than domestic ones in citation impact. But gaps between countries are narrowing.

**Conclusions:** International collaboration really intensified in this field. European, especially Nordic countries are very fond of collaboration and have gained outstanding performance as a partner. It is meaningful to further explore the underlying motivation behind international collaboration in sport science research.

**Keywords:** collaboration, citation impact

## INTRODUCTION

Bibliometrics is a set of methods in library and information science to study the patterns of publications.<sup>1</sup> It has become a useful method to track the academic progression. In sport sciences, there are already some articles using bibliometrics to explore the disciplines development. Most of them made bibliometric studies on specific sports or topics, such as judo, rugby, physical activity and aging, anabolic steroids and drug abuse, rehabilitation, disability sport, adapted physical activity, cardiology and sport and sport psychology.<sup>2-10</sup> Others just focus on one journal, such as *International Review for the Sociology of Sport*,<sup>11</sup> *Journal of Orthopaedic & Sports Physical Therapy*,<sup>12</sup> *Journal of Rehabilitation and Medicine*,<sup>13,14</sup> or on several journals, normally relate to sub-disciplines in sport sciences, such as physical and rehabilitation medicine, rehabilitation, sport management and marketing or sports economics.<sup>15-18</sup> Sometimes they also focus on sport sciences in specific country or region, such as Spain, Iran, Croatia and South America.<sup>19-22</sup> Only a few articles studied sport sciences covering the entire discipline.<sup>23,24</sup>

The above mentioned papers study mainly trends in publication output and citation impact, at different levels of aggregation like authors, institutions and countries. Indicators often include publication counts and citations per article. And the Impact Factor is still the most commonly used indicator, sometimes in combination with other indicators like SJR.<sup>13,15</sup> Some researchers are keen on exploring the fulfilment of Price, Lotka and Bradford Laws in sport sciences.<sup>2,3,8</sup> Overall speaking, all these studies find a growing trend of sport sciences publications, including the international publications. Some authors summed up the reasons for the observed increase: the proliferation of English has made it the standard academic language; the Internet has made the communication easier and cheaper; publishing on journals indexed by ISI database becomes a criterion for academic evaluation and the extended cov-

erage of this bibliographic database.<sup>16</sup> Meanwhile, in order to increase the journals' international contacts, more foreign experts are accepted as members of Editorial Boards,<sup>14</sup> which also contributes to the increase of international articles and international collaboration. In addition, the increased ratio of multi-authored papers is similar to results of other disciplines.<sup>16,25</sup> Interestingly, some find that the publication output on a specific topic at country level has a similar pattern as competitive sport performances.<sup>2,3</sup>

As an important topic, collaboration also is mentioned in these studies. A common approach is to use co-authorship network analysis to identify author clusters.<sup>2,5</sup> The benefits and challenges of collaborative research in sport also are discussed.<sup>26</sup> Some researchers find the collaboration tendency of in specific sport topics, such as Spain tend to work with South America, and Iran prefers to collaborate with English-speaking countries, like Canada, England, Australia and the USA.<sup>19,20</sup> Compared with other disciplines, such as mathematics, physics and biology, international collaboration in sport sciences has not been adequately studied, especially from the macro-level perspective.<sup>27-30</sup> Do sport sciences tend to research alone like mathematics, or tend to study with a big team like biology? Or whether collaboration in sport sciences enhances productivity? Does international collaborated publications have a higher citation impact than domestic ones? Is there some close partnership between certain countries in sport sciences? This paper, based on bibliographic data of two periods (2000-2001 & 2010-2011) from sport sciences journals, aims to observe the status and trends of international collaboration in sport sciences from the macro-level perspective and explore its influence on citation impact.

## COLLABORATION RESEARCH IN BIBLIOMETRICS

Scientific collaboration itself has become one of the favorite topics in bibliometric research. The first comprehensive study on interna-

tional collaboration using co-operativity measures has been published by Schubert and Braun and found a dramatic increase of international collaboration on the SCI publications.<sup>31</sup> Of course, not all countries showed an increasing trend, such as in Turkey, South Korea and Saudi Arabia the share of international co-authored publications decreased. They also found that foreign co-authorship can be approximated by national publication productivity through a power law in which the exponent is less than one. Although big countries have a relatively lower share of international co-publications than medium-sized or small countries have, the increase is thus a global law independently of the countries' size. Glänzel and Schubert studied international co-authorship networks and found the collaboration has been intensified and the density of the networks has increased.<sup>32</sup> International co-authorship links will undergo dramatic structural changes over time and collaboration is determined by geographical, political, economic and other reasons. In addition to the symmetric network analysis, some scientists also observed the asymmetric network (specific unidirectional 'affinities' between countries), a possible way to characterize the relative 'importance' of other countries for selected countries.<sup>33</sup> Glänzel even outlined a methodological scheme for the analysis of international co-publication patterns. Besides, the relationship between collaboration and scientific productivity also is an important research point.<sup>34</sup> Some scientists, explored the idea that "collaboration will increase productivity", and found that this does not necessary always hold.<sup>35,36</sup> In different fields, cooperation may have different correlations, even positive relationship, with productivity.

## METHODS

### DATA RETRIEVAL

The results of the present study are based on the bibliographic data extracted from

the 2000–2001 and 2010–2011 volumes of Thomson Reuters Web of Science (WoS). Only the document types Articles, Notes, Proceedings Papers and Reviews, assigned to the Subject Category *Sport Sciences* were taken into consideration. Finally, 63 consistently issued journals were covered by the SCI-EXPANDED (SCIE) database in one or both periods, so only documents published in these journals were used in this study. Changes of journal titles have been considered. Publications were assigned to countries on the basis of their corporate addresses, which appear in the by-line of the publication.

The main purpose of this study is to observe the international collaboration in sport sciences, and not to explore research topics or themes. According to this aim, limiting the publication set to the Sport Sciences category is appropriate to fulfil this task. So we did not collect publications outside this category related to sport research.

Altogether, 8,304 publications from 2000–2001, and 12,500 publications from 2010–2011 met the selection criteria. Their Accession Number, Addresses, Publication Year and all citation information were downloaded and were imported into an Oracle database for further analysis.

### DATA PROCESSING

In this paper, when two or more countries appear in the author's addresses of one publication, it is considered to be an international collaborated publication and it is counted in full for each of the contributing countries. Also for the citations we apply this full counting scheme. For the analysis of the international collaboration strength between country pairs, we used the Salton's cosine measure.<sup>37</sup>

For the citation analysis, a three-year citation window has been applied, beginning with the publication year and next 2 years (e.g. 2000, 2001, 2002 three years for papers published in 2000). The definition of self-citation applied in this study was the same as that applied earlier, e.g., by Snyder and Bonzi.<sup>38</sup>

MOCR, MECR and RCR were chosen as the citation indicators. They can be presented in tables or plotted in relational charts and have proven to be useful instruments in cross-national comparisons of national research performance. So definitions of these indicators are as follows:

- ▶ Mean Observed Citation Rate (MOCR) is defined as the ratio of citation count to publication count.
- ▶ Mean Expected Citation Rate (MECR) is defined as the ratio of the expected citation count to publication count. The expected citation count is calculated on the basis of the average number of citations that papers have received in each particular journal within the same citation window.
- ▶ Relative Citation Rate (RCR) is the ratio of MOCR to MECR.<sup>39</sup> RCR=0 corresponds to uncitedness; RCR<1 represents an observed citation impact lower than can be expected; RCR>1 represents higher-than-the-average and finally RCR=1 means that the papers received the number of citations expected on the basis of the average citation rate of the publishing journals.

## RESULTS

### BASIC DATA

Although publications are limited to 63 journals, there is a big increase in the total amount of publications. On the other hand, the growth of publications (50.5%) is significantly slower than that of citations (142.1%), which results in a substantial increase of impact factors. Here the “domestic publications” refers all publications whose corpo-

Periods	2000-2001	2010-2011
Publications	8304	12500
International Publications (%)	14.4%	22.6%
Citations	22629	54779
Self-Citations (%)	28.2%	23.9%

**Table 1.** Data overview of two periods (Data sourced from Thomson Reuters' Web of Science Core Collection)

rate addresses are only from one country, and correspondingly, “international publications” means that there are two or more countries in corporate addresses. As been shown, the share of self-citations decreased in spite of the increase of the share of international collaborated publications, so international collaboration in sport sciences has indeed broaden the audiences.

### SHARE OF INTERNATIONALLY CO-AUTHORED PUBLICATIONS

International collaboration can be traced back to the 19th century.<sup>40</sup> However, many recent studies have shown that this phenomenon has increased during the last two decades.<sup>32,34,41,42</sup> Several factors, such as cost-savings, the growing importance of interdisciplinary fields and geographical, economic or cultural interests are pointed out to contribute for the establishment of international collaboration.<sup>43</sup> The absolute number of international papers and their share in the total national publication output serve as basic indicators of international co-authorship and scientific collaboration. Table 1 presents the national publication output, the share of international co-authored publications to the national total and the share of national publication output to the world total in sport sciences in each of the two periods.

Similar to many other research fields, USA is the most prolific country in sport sciences. In the first period, New Zealand, Brazil and Portugal have the highest share of international papers. Exactly the reverse, Turkey, and USA have the lowest share of international papers, and the amount of papers of the latter one is nearly half of the world total. So in the first period, it could be said that international collaboration in sport science is not very common. In the second period, the growth of the world total outputs (50.5%) is far beyond the growth of USA (18.3%). Almost all countries show an increase in their share to the world total, except for six countries where the 'B' value

Rank	Country/Region	2000/2001			2010/2011		
		Papers	A(%)	B(%)	Papers	A(%)	B(%)
1	Switzerland	126	48.4	1.52	397	70.3	3.18
2	Ireland	30	33.3	0.36	92	67.4	0.74
3	Portugal	/	/	/	117	66.7	0.94
4	New Zealand	84	59.5	1.01	284	66.5	2.27
5	Sweden	224	31.3	2.70	333	58.0	2.66
6	Austria	64	48.4	0.77	133	54.9	1.06
7	Norway	68	25.0	0.82	258	54.7	2.06
8	Denmark	122	32.8	1.47	230	54.3	1.84
9	South Africa	40	47.5	0.48	81	54.3	0.65
10	Spain	76	34.2	0.92	374	51.1	2.99
11	Australia	466	31.3	5.61	1078	49.6	8.62
12	UK	718	26.2	8.65	1319	48.9	10.55
13	Finland	139	38.1	1.67	119	47.9	0.95
14	Belgium	107	30.8	1.29	252	47.6	2.02
15	Italy	223	29.1	2.69	508	45.9	4.06
16	France	373	28.4	4.49	584	45.0	4.67
17	Netherlands	210	39.0	2.53	451	43.2	3.61
18	P R China	52	36.5	0.63	250	43.2	2.00
19	Canada	766	33.7	9.22	1012	42.0	8.10
20	Germany	359	26.5	4.32	728	40.8	5.82
21	Brazil	37	54.1	0.45	369	40.7	2.95
22	Greece	49	49.0	0.59	135	40.0	1.08
23	Israel	76	39.5	0.92	100	39.0	0.80
24	South Korea	24	33.3	0.29	275	25.1	2.20
25	Poland	56	23.2	0.67	89	22.5	0.71
26	Taiwan	71	23.9	0.86	173	22.0	1.38
27	USA	4106	13.3	49.45	4857	21.8	38.86
28	Japan	412	20.1	4.96	535	19.6	4.28
29	Turkey	38	10.5	0.46	131	18.3	1.05
	<i>World</i>	8304			12500		

**Table 2.** Scientific output, share of international co-publications in each country and share of every country in the world. Ranked by 'A' in 2010/11 (A: share of international co-authored papers to national total outputs, B: share of national outputs to the world total outputs; World values are set in italics); "/": In 2000/01 Portugal has no data because its literatures are less than 10. (Data sourced from Thomson Reuters' Web of Science Core Collection)

drops. USA has the largest decline in share but holds its position as leading country. And of course, there is a general increase in indicator 'A', except for a decrease in 7 countries. Although the 'A' indicator for

USA increases a lot in 2010/11, USA still ranks low in this indicator among the 29 selected countries. It is worth noting that there is a significant decrease of Brazil in 'A' (from 54.1% to 40.7%). In this period, the

most internationalized countries in sport sciences research are Switzerland, Ireland and New Zealand. The share of these countries' international co-authored papers was even higher than two-thirds. 18 countries have an increase in both indicators, and the growth of 'A' was greater than 'B' in these countries. It indicates that the growth of national total outputs mainly due to the growth of international papers. UK, Australia, Germany, Italy and Norway all have a faster growth than the other countries in both two indicators.

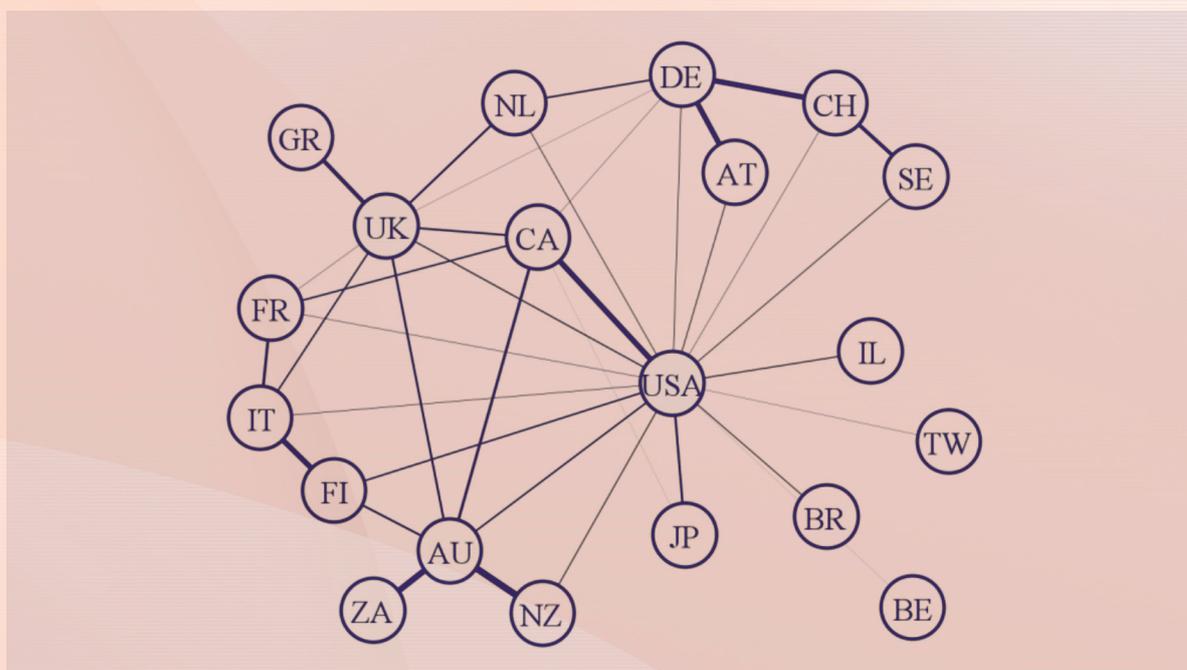
It is worth mentioning that Brazil and South Korea both have an increase in 'B' value and a decrease in 'A' value. This indicates that these two countries' authors pay more attention on domestic partnership or independent research, which led to the overall increase of their national outputs.

#### CO-AUTHORSHIP LINKS

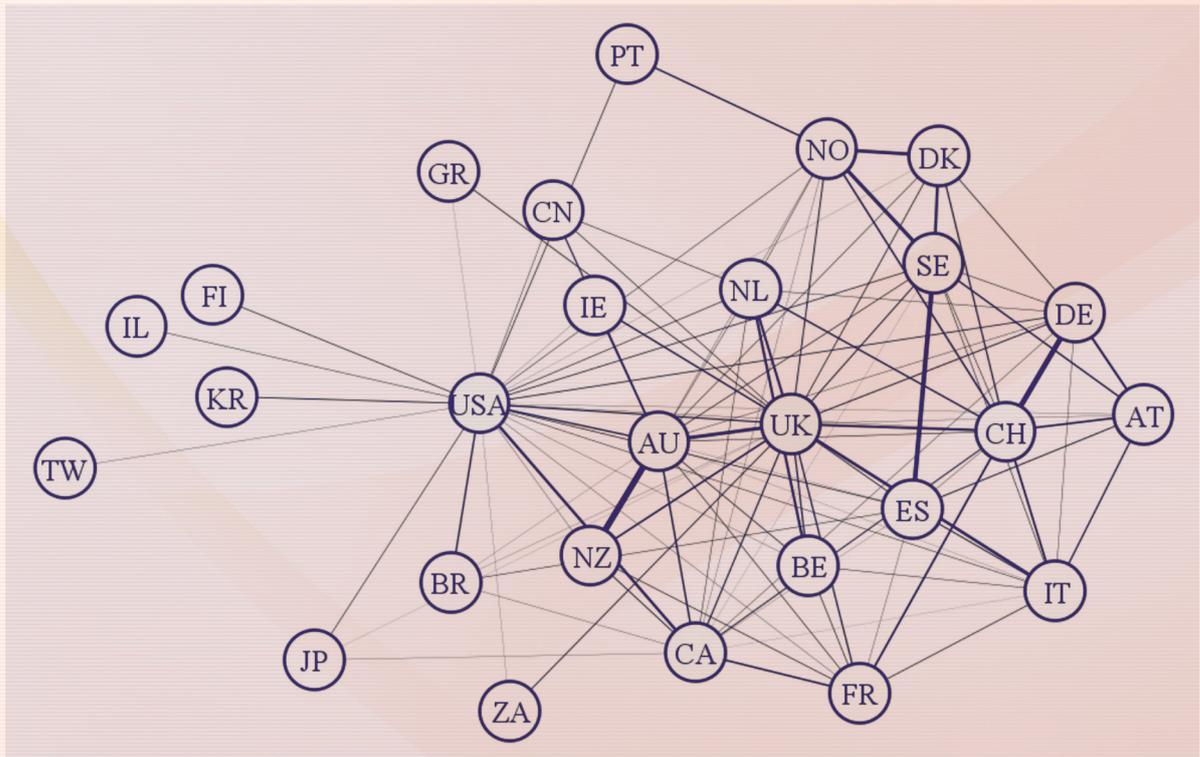
As Leta et al. have mentioned, the analysis of international co-authorship patterns by country pairs is the most intelligible approach to analyse the strength of collaboration links of a given country with other

countries.<sup>41</sup> Here, we only consider the international collaboration links with more than 10 co-publications. In the co-authorship analyses, weighted links between countries or regions were studied. A link between two countries is established whenever the two given countries co-occurred in the corporate address in the by-line of a publication. Salton's measure is used as a measure of international collaboration strength. The collaboration matrix was imported into Pajek to create an undirected map (Figure 1a-1b).<sup>44</sup> The depth of the line between each country pairs represents the value of Salton's measure. For a simplified representation of the network, only relations that reached a minimum strength (cosine value above 0.02) are showed here.

In 2000/01, 20 countries have a co-authorship with other countries, and USA, clearly, locates in the center. There are some strong relationships between USA and Canada, Germany and Switzerland, Germany and Austria, Australia and New Zealand, Australia and South Africa, Finland and Italy (Salton's cosine measure value is above 3.9). No strong triads are observed. In 2010/11, 27 countries form a cooperative



**Figure 1a.** International collaboration map for most active countries in sport sciences in 2000/01 based on Salton's measure (line thickness according to the cosine value). (Data sourced from Thomson Reuters' Web of Science Core Collection)



**Figure 1b.** International collaboration map for most active countries in sport sciences in 2010/11 based on Salton's measure (line thickness according to the cosine value). (Data sourced from Thomson Reuters' Web of Science Core Collection)

network. The sub-network that most European countries formed intensified and Australia and UK seem to lie with USA in the center of the whole network. Several strong triads pop up in the last period.

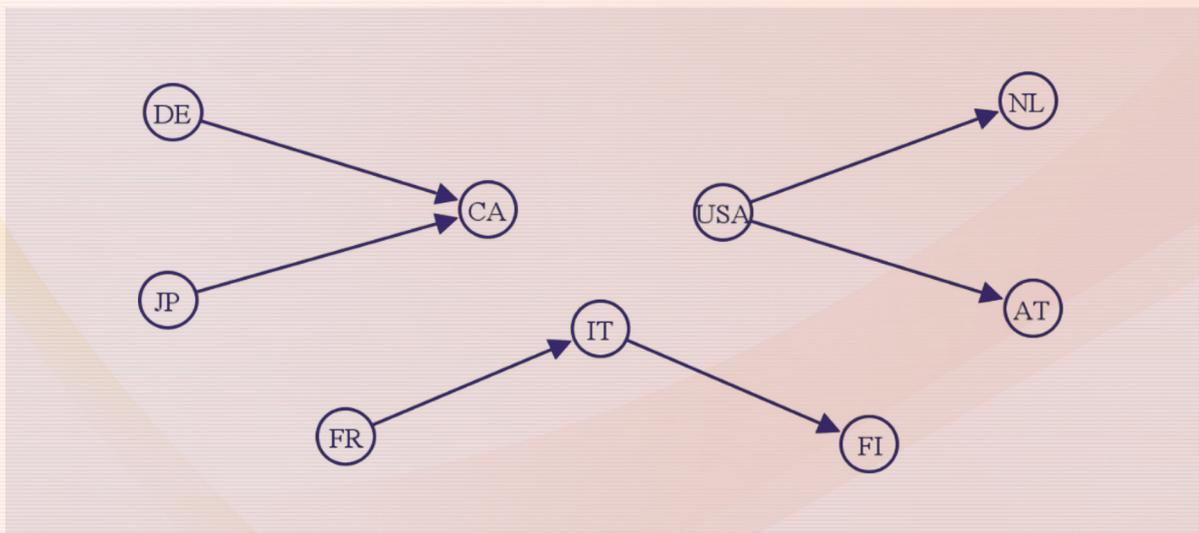
South Africa has shifted his main collaboration partner from Australia in 2000/01 to UK and USA in 2010/11. It is worth mentioning that the Nordic countries strengthened their inner cooperation in sport sciences in 2010/11 with exception of Finland who preferred to collaborate with USA. Brazil doubles its collaboration strength with USA. Half of the international co-authored papers of Brazil are published in collaboration with USA., while its share of international papers declined to 13.4%. Different to South Africa and Brazil, China strengthens its cooperation with Australia and several European countries in 2010/11, although at the same time USA still plays its most important international partner. There are several strong collaboration links, like USA-Canada, Germany-Switzerland, Australia-New Zealand, which all remain stable in

two periods. Geographical and cultural factors may be the main reason for these stable country pairs collaboration.

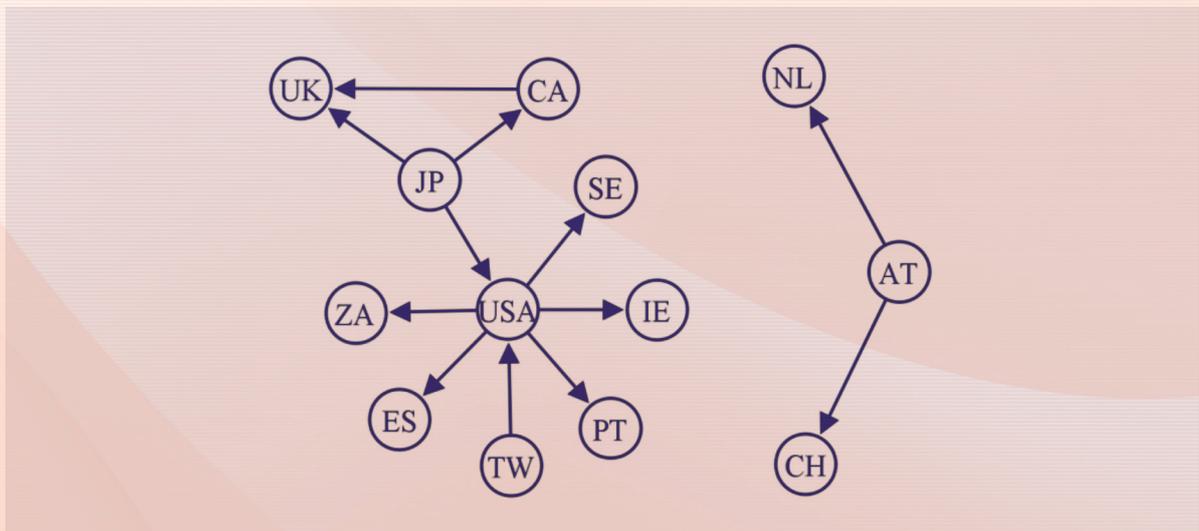
#### CO-AUTHORSHIP "AFFINITY": ASYMMETRY IN CO-AUTHORSHIP RELATIONSHIP

The "co-authorship affinity" has been mentioned and measured before.<sup>45</sup> The affinity between a selected country and one of its collaborating partners can be explained as the share of one partner country in the internationally co-authored papers of the selected country divided by the share of the total number of this partner country's publications in the "rest of the world" total, i.e., the world total minus the number of publications of the selected country. A formal definition can be found in Schubert and Glänzel (2006).<sup>46</sup>

In general, this affinity relationship between two countries is asymmetrical. In order to make comparisons convenient, the direct and reverse indicator values of spe-



**Figure 2a.** Directed graph of strongly asymmetric co-authorship links in 2000/2001 (Data sourced from Thomson Reuters' Web of Science Core Collection)



**Figure 2b.** Directed graph of strongly asymmetric co-authorship links in 2010/2011 (Data sourced from Thomson Reuters' Web of Science Core Collection)

cific co-authorship affinity are showed in table 4 and 5 (Appendix). For example, in 2000/01, the direct value of the USA→UK affinity is thus 0.58 (9.9% vs. 17.1%), while for the reverse value, UK→USA, its value is 0.53 (28.7% vs. 54.1%). Since there are too many zero values, we only show the specific affinity values of the 29 selected countries toward the 7 most important partner countries. (No values are indicated where the number of joint publications was less than 10).

In 2000/01, there are 5 values above 10, for example, Australia→New Zealand. And two values are close to 10, UK→Greece and Sweden→Switzerland. These “excessive af-

finity”, which means that indicator ‘A’ has 10 times the value of indicator ‘B’, have been presented in symmetrical co-authorship links. But at the same time, this asymmetric co-authorship shows that it is not so intimate between these each country pairs in the opposite direction, which cannot be seen in undirectional mapping.

Glänzel and Schubert also mentioned strongly asymmetric “skew pairs”, i.e., those cases where the indicator value in one direction is less than 1, while in the reverse direction it is greater than 1.<sup>45</sup> In 2000/01, we find 6 “skew pairs”, e.g., New Zealand is somewhat “over-represented” as a co-operating partner

for USA, while USA is definitely “under-represented” as a partner for New Zealand. The same phenomenon occurs in the rather unidirectional USA→Austria, Canada→Germany, Canada→Japan, Finland→Italy, France→Italy relationships.

In 2010/11, “excessive affinity” almost disappears, which means most countries try to collaborate with more partners, of course, given that the share of the total publication output of each country (except for the USA) is increasing. We still can see some strong affinities, e.g., in Germany↔Switzerland, Germany↔Austria, Netherlands↔Belgium, Australia↔New Zealand (bidirectional). But for most countries, the corresponding indicator values are below 3. It is worth mentioning that there are twelve “skew pairs” in this period. A possible reason for the sudden increase of this kind of pairs is that the number of joint papers has increased in 2010/11 and passes the threshold of 10.

Figure 2a and 2b display in a directed graph format the strongly asymmetric “skew pairs” in two periods. If arrow points from X to Y, it means X→Y co-authorship affinity value is greater than 1, while in the reverse direction, Y→X affinity value is less than 1. In 2000/01, Canada seemed to be an attraction node in the collaboration network. USA and Italy were in an “intermediary position”. In 2010/11 the situation somewhat changed, as Japan and Austria have become a “repulsion node”, while UK seemed to be an “attraction node”. USA was again in a “intermediary” position, particularly, “repulsing” for Europe and “attracting” for Asia.

#### INTERNATIONAL CO-AUTHORSHIP AND CITATION IMPACT

The Mean Observed Citation Rate (MOCR) reflects the factual citation impact of a unit, whereas the Mean Expected Citation Rate (MECR) is based on the 3-year mean citation rate of the journals in which the unit under study has been publishing. This journal citation measure is used as the reference standard for papers published in the

corresponding journal. Here a unit is the country. Relative Citation Rate (RCR) is defined as the ratio of the observed and the journal-based expected citation impact, that is,  $RCR = MOCR/MECR$ . RCR measures whether the publications of a country attract more or less citations than expected on the basis of the average citation rates of the journals in which they appeared. The indicator ranges between 0 and infinity, the neutral value is 1.  $RCR < 1$  ( $RCR > 1$ ) means a citation score below (above) expectation. The MOCR and RCR for all papers combined and for international publications of 29 selected countries are showed in table 3.

The standard deviation of  $RCR_{int}$  decreases from 0.34 in 2000/01 to 0.19 in 2010/11. All international co-authored publications tend to perform better in the second period. The biggest rise of  $RCR_{int}$  comes from Turkey (from 0.29 to 1.21) and Poland (from 0.65 to 1.40). In Figure 3b, countries seem to concentrate together, and distribute on the top of the diagonal. That means international collaborations of these countries are getting more citations than before. Vice versa, eight countries have a decrease in  $RCR_{int}$ . By the way, only Brazil, Japan, South Korea and Taiwan have a  $RCR_{int}$  value less than 1, and the largest decline comes from South Korea (from 1.86 to 0.93).

In order to gain more insight into the citation impact and the publication strategy in sport sciences, the citation-impact relational charts for 29 selected countries are presented in figure 3a-3b. The country labels used are the same as in Table 2. The horizontal and vertical lines indicate the rate of each country observed or expected citation impact to the standard in the world in sport sciences. The standard in the world is the mean citation rate of all papers published in the same period in sport sciences (limited to 63 journals in this study). The diagonal line indicates  $RCR=1$ . Above the diagonal means the country has a higher citation score than average,  $RCR > 1$ . Vice versa,  $RCR < 1$ . So we can see the difference of  $MOCR_{int}$ ,  $MECR_{int}$  and  $RCR_{int}$  value of

Label	Country/ Region	2000-2001			2010-2011		
		MOCR <sub>all</sub>	RCR <sub>all</sub>	RCR <sub>int</sub>	MOCR <sub>all</sub>	RCR <sub>all</sub>	RCR <sub>int</sub>
0	Australia	3.40	1.20	1.47	6.17	1.25	1.31
1	Austria	2.84	1.03	1.39	4.36	1.08	1.21
2	Belgium	3.03	1.03	1.09	5.62	1.25	1.43
3	Brazil	2.30	0.69	0.54	3.50	0.87	0.92
4	Canada	3.57	1.16	1.39	4.87	1.13	1.33
5	Denmark	4.11	1.26	1.09	7.49	1.46	1.81
6	Finland	3.70	1.30	1.52	4.49	1.01	1.29
7	France	2.17	0.88	1.06	4.16	1.07	1.36
8	Germany	2.59	1.10	1.38	4.35	1.13	1.40
9	Greece	1.08	0.54	0.69	3.96	0.96	1.19
A	Ireland	2.83	1.01	1.52	5.00	1.15	1.31
B	Israel	1.72	0.67	0.78	3.75	0.96	1.28
C	Italy	2.42	1.03	1.13	5.17	1.26	1.43
D	Japan	2.17	0.89	1.04	3.06	0.76	0.90
E	Netherlands	2.92	0.98	1.03	5.81	1.27	1.47
F	New Zealand	3.04	1.07	1.06	4.64	1.04	1.10
G	Norway	2.96	1.06	1.28	6.34	1.27	1.38
H	P R China	1.83	0.74	0.83	3.59	0.88	1.02
I	Poland	1.13	0.76	0.65	2.26	0.94	1.40
J	Portugal	2.00	0.92	0.88	4.32	1.18	1.24
K	South Africa	3.65	1.27	1.58	5.94	1.11	1.24
L	South Korea	2.38	1.11	1.86	3.87	0.85	0.93
M	Spain	4.38	1.39	1.22	5.21	1.27	1.47
N	Sweden	3.5	1.27	1.43	6.76	1.44	1.50
O	Switzerland	2.95	1.13	1.22	5.82	1.33	1.47
P	Taiwan	1.89	0.69	0.73	3.03	0.73	0.96
Q	Turkey	0.95	0.44	0.29	2.53	0.78	1.21
R	UK	2.42	1.04	1.16	5.19	1.16	1.29
S	USA	3.08	1.11	1.20	4.55	1.10	1.21

**Table 3.** Relative citation indicators of international publications  
(Data sourced from Thomson Reuters' Web of Science Core Collection)

publications between 29 selected countries in one figure. In 2000/01, it seems that Spain (M) and Denmark (5) were able to publish in highly cited journals (highest ME<sub>CR</sub><sub>all</sub> values), and indeed these papers attracted relatively more citations than other countries. Finland and Ireland have

the best performance on their international papers in sport sciences. Overall, there are only 6 countries' ME<sub>CR</sub><sub>int</sub> (ME<sub>CR</sub> for international papers) value lower than ME<sub>CR</sub><sub>all</sub> (ME<sub>CR</sub> for total papers) value, with the biggest deviation in Turkey and Brazil (0.45) and only 4 countries' ME<sub>CR</sub><sub>int</sub> (ME<sub>CR</sub>

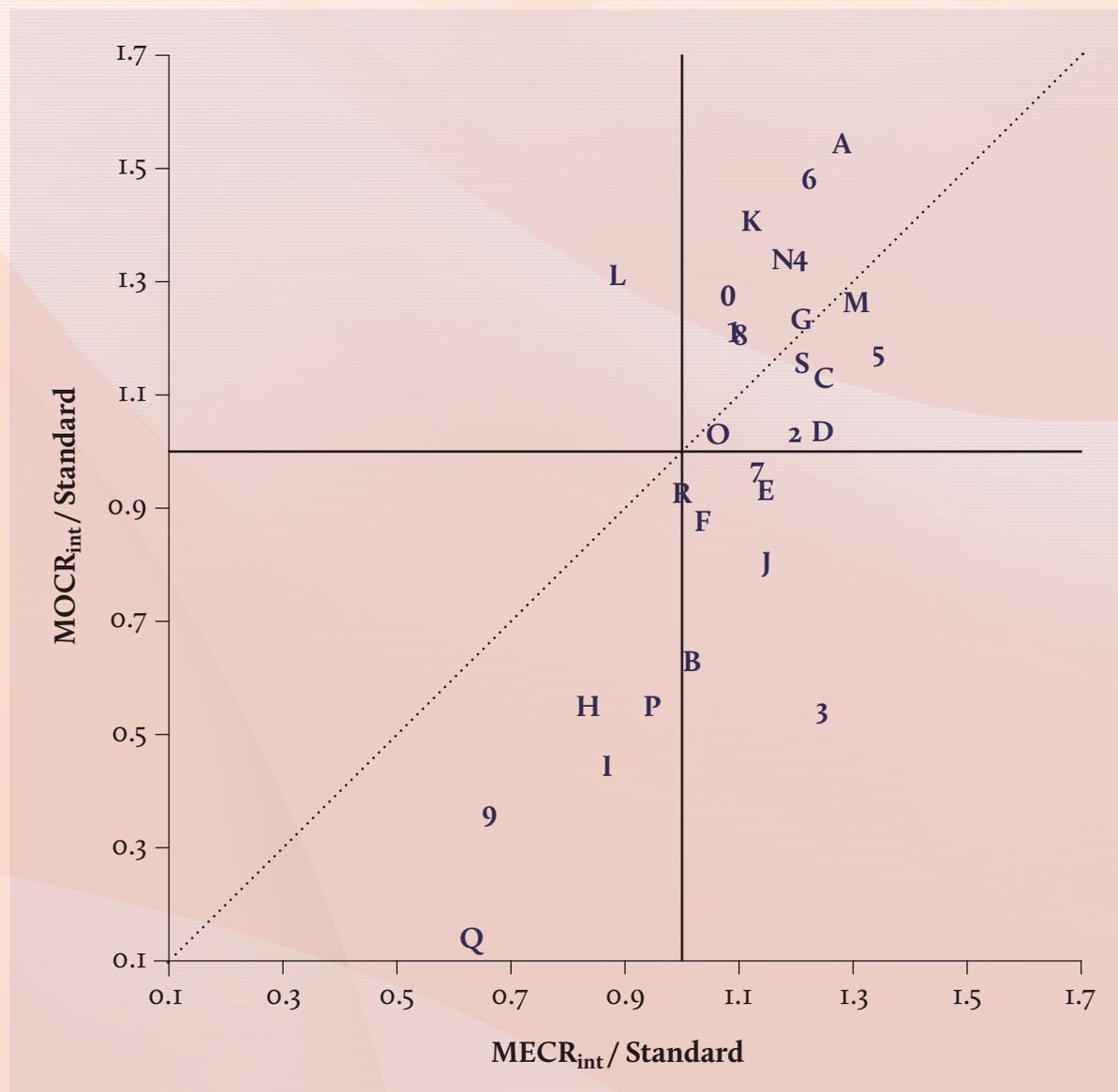
for international papers) value lower than  $MECR_{all}$  ( $MECR$  for total papers) value, with the largest deviation in Turkey (0.43).

In 2010/11, somewhat changed and nearly in all selected countries the  $MOCR_{int}$  value is higher than  $MOCR_{all}$  value, and the largest deviation in this respect can be observed for Turkey and Poland. Finally, only 6 countries'  $MECR_{int}$  value was lower than  $MECR_{all}$  value. A closer look at the differences in citation impact between two periods provides the following picture: all selected countries have an increase in  $MOCR_{all}$  value. Only South Korea shows a decrease (0.64) in  $MOCR_{int}$  value. Denmark, Greece

and Turkey have a big increase (avg. 4.79) in  $MOCR_{int}$  value. That means international collaborated papers for these countries have attracted above on an average 4 more citations for each paper than before.

CITATION DISTRIBUTIONS OVER DOMESTIC AND INTERNATIONAL PAPERS

Figures 4a and 4b present a comparison of the frequency distribution of citations received by domestic and international papers for all selected countries in sport sciences in 2000/01 and 2010/11 respectively. Figure 4b is less polarized, and has longer tail.

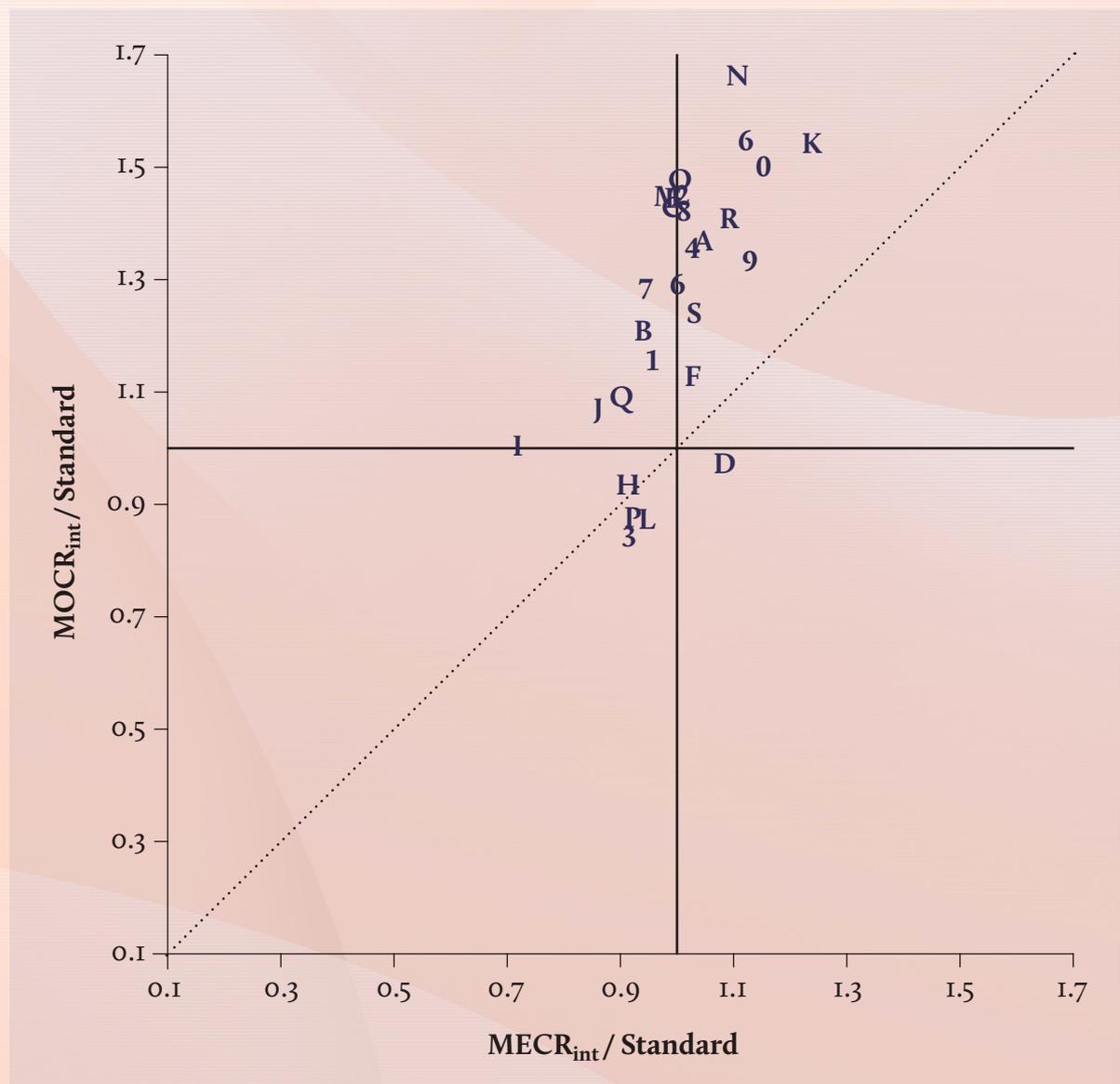


**Figure 3a.** Relational chart of expected and observed citation rate of international publications for 29 selected countries  $MECR/Standard$  vs.  $MOCR/Standard$  in 2000/2001. (Data sourced from Thomson Reuters' Web of Science Core Collection)

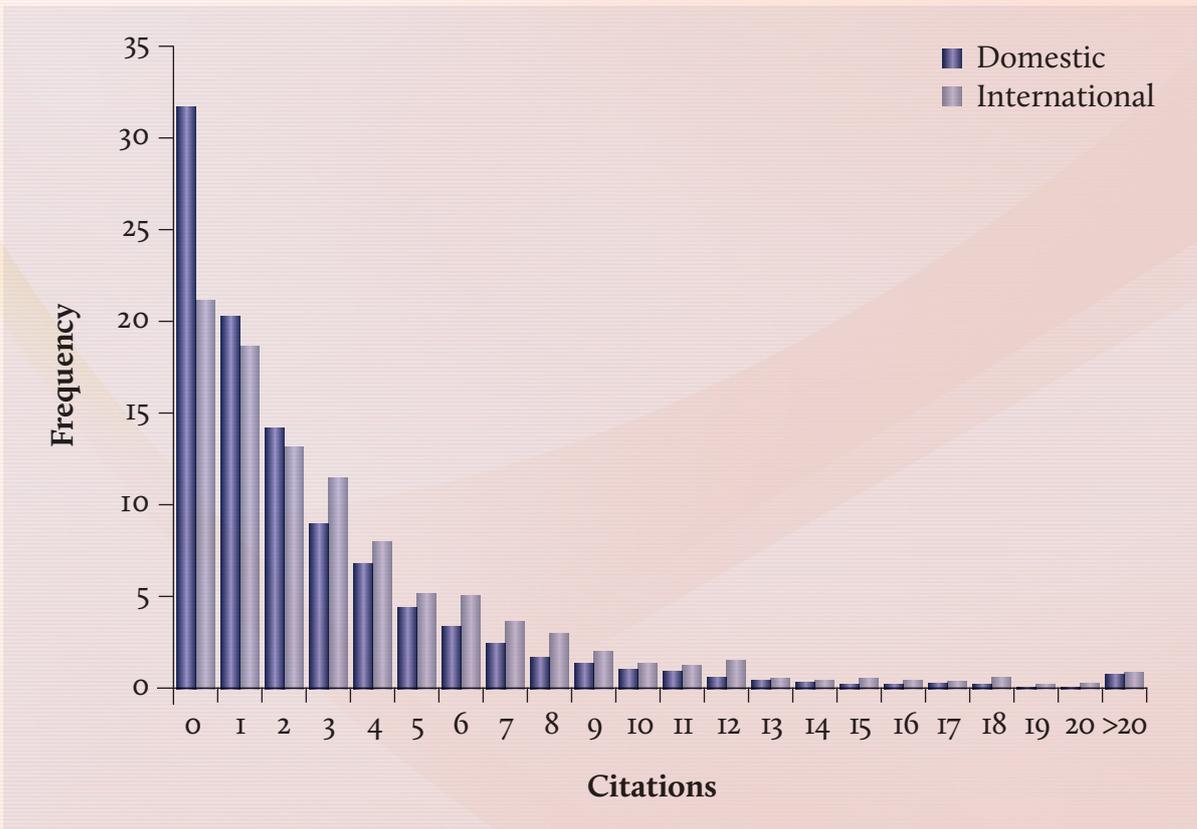
In 2000/01, 51.8% of domestic papers were uncited or cited only 1 time. This percentage dropped to 36.4% in 2010/11. So the 'head' of the distribution was getting smaller, and at the same time, the 'trunk' and the 'tail' becomes longer. In 2000/01, 21.1% of international papers were uncited, but this percentage was 12.4% in 2010/11. And papers cited 3 times have the highest percentage (14.0%). The proportion of international papers cited more than 20 times increased a lot from 0.88% to 3.14% (longer tail).

We only show the distribution citations of total publications in all selected countries.

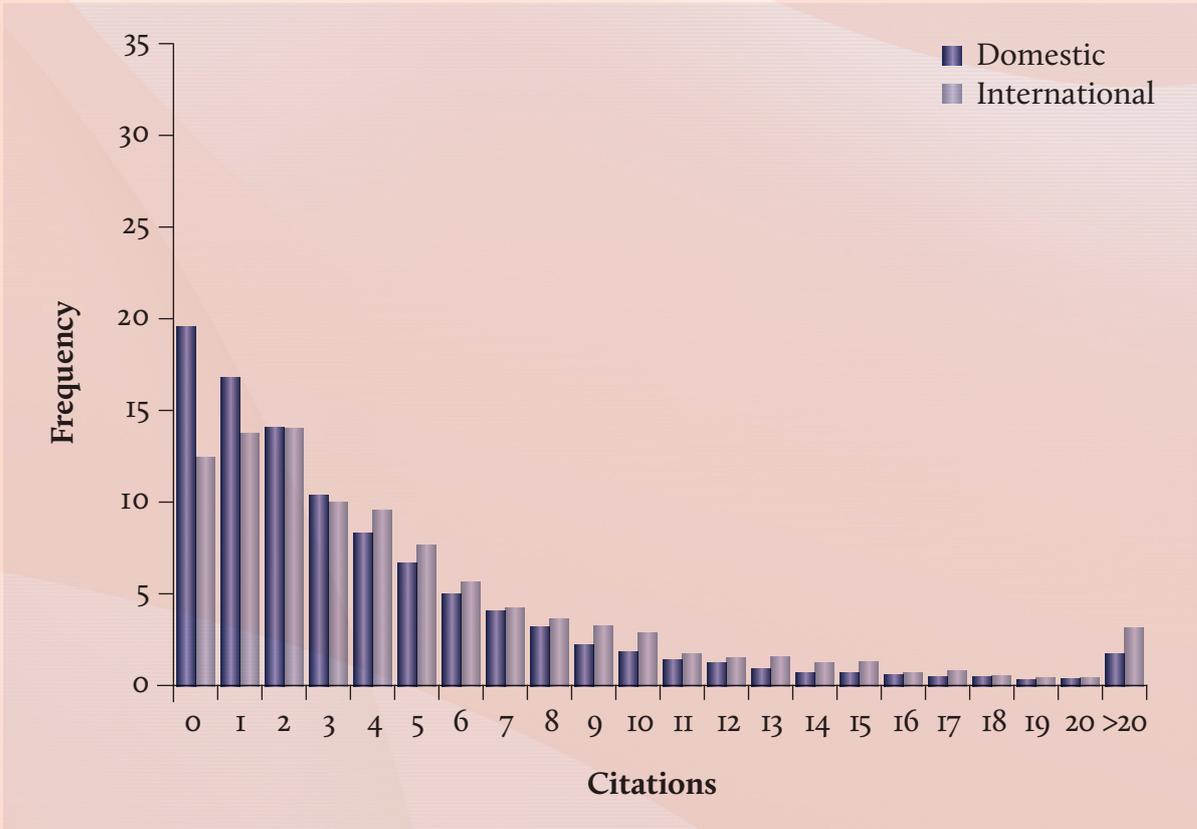
We will find a significant difference if we compare distributions of citations between different countries. Prolific countries' distribution of citations is more similar to the overall. Low-yielding countries show a more random distribution, such as 2 or 3 bulges in the middle. While Nordic countries tend to exhibit one bulge in the front middle of the distribution. It means that the percentage of domestic publications cited 1 or 2 times usually accounts for the first and the percentage of international publications cited 2 or 3 times ranks first. Of course, bulges move towards the tail in the second period.



**Figure 3b.** Relational chart of expected and observed citation rate of international publications for 29 selected countries MECR/Standard vs. MOCR/Standard in 2010/2011. (Data sourced from Thomson Reuters' Web of Science Core Collection)



**Figure 4a.** Frequency distributions of citations over domestic vs. international publications in 2000/01. (dark: distribution in domestic publications, light: distribution in international publications). (Data sourced from Thomson Reuters' Web of Science Core Collection)



**Figure 4b.** Frequency distributions of citations over domestic vs. international publications in 2010/11. (dark: distribution in domestic publications, light: distribution in international publications). (Data sourced from Thomson Reuters' Web of Science Core Collection)

## CITATION ANALYSIS OF CO-AUTHORSHIP LINKS BY COUNTRY-PAIRS

In this part, the expected and observed citation rates of international co-publications will be analyzed through country pairs. Similar to previous sections, in order to obtain statistically reliable results, links with less than 10 joint papers were omitted. The indicators for seven selected countries are presented in tables 6 and 7 (Appendix). Table 6 shows the mean observed and expected citation rates of co-authorship links of USA, UK, Canada, Germany, Australia, Netherlands and Switzerland with their partner countries in sport sciences publications in 2000/2001. Data are arranged in descending order by the observed citation rates. All citation data are based on 3-year citation windows.

The field impact of sport sciences is 2.73 in 2000/01. Almost all the seven selected countries have higher citation rates for their international co-publications than for their domestic publications. The selected countries' MOCR values for domestic publications are almost at the bottom of each column and their values are around the field impact value. Strong links with a mean citation rate greater than the domestic MOCR of any of the two contributing countries were called *hot links*.<sup>45</sup> In this paper, according to this definition, the following links definitely may serve as examples for such *hot links*: USA-Canada ( $r_{ij}=8.1\%$ ,  $\text{MOCR}=5.01$ ), Switzerland-Sweden ( $r_{ij}=6.0\%$ ,  $\text{MOCR}=6.30$ ). ( $r$  means Salton's cosine measure value).

USA has many co-publication links and most of them have MOCR and MECR values distinctly above the field impact standard. And it is worth mentioning that USA, Canada, Australia and Netherlands' MOCR value for domestic publications all lie above the field impact standard. Nevertheless, the 'hottest' link could be Germany-Austria ( $r_{ij}=7.9\%$ ,  $\text{MOCR}=6.92$ ). *Cool links*, co-authorship links with a mean citation rate smaller than the corresponding domestic MOCR values of two contributing countries, also could be seen in table 6, such as UK-Greece and USA-Brazil.<sup>45</sup>

In 2010/01, more co-authorship links are presented in table 7. The field impact increased to 4.38 and MOCR values generally increased a lot. The co-authorship links between Denmark and 4 selected countries (USA, UK, Australia, Germany) have a high MOCR above 15. Especially, Australia-Denmark and USA-Denmark co-publications' MOCR are above 20. It is worth mentioning that Australia, Denmark, Netherlands, Norway and Sweden's domestic publications' MOCR are all above the field impact standard. And several *hot links* are found around these countries. Germany-Austria is not the 'hottest link' any more. While, these links, Switzerland-Denmark, Switzerland-France, and Australia-Canada, could be called *hot links*. While only Australia-China link could be called *cool link*. Surprisingly, three Nordic countries, Denmark, Sweden and Norway show impressive citation results as a partner.

This section illustrates that international co-authorship in sport sciences generally attracts more citations than domestic publications. Two collaborated partners with high value of domestic publications MOCR normally will publish papers with higher value of MOCR. Of course, in few cases, international collaboration even attracts less citations than domestic standards of both partner(s). *Cool links* seems to have happened to those countries with lowest value of domestic publications' MOCR in this field.

## DISCUSSION

This study tried to explore the status of international collaboration in sport sciences and its influence on citation impact, while prior studies have provided strong evidence that international collaboration is increasing in many other disciplines and some subjects in sport sciences.<sup>2,4,5,28-30</sup> Now results presented here clearly suggest a significant increase of collaboration in sport sciences and a large increase in citation impacts of international co-authored publications at a macro-level perspective. These results also

raise a number of issues with implications for future work related to collaboration and collaboration propensity in sport sciences.

#### COLLABORATION AS THE DRIVE OF GROWTH

Physiologically, sport sciences is a discipline that studies how different parts of human body collaborate during exercise, and how this collaborative work promote health or fitness from different perspectives. Sociologically, athletes have to collaborate with coaches, and they all have to collaborate with a multidisciplinary team to improve performances by sharing information and making team-decisions.<sup>47</sup> Operationally, sports need four elements: technical, tactical, physical, and mental abilities, to work together. Originally, the formation of sport sciences just integrated technologies and achievements of multidisciplinary, especially electrophysiology and biomechanics. And today further subdivision of sport sciences need multidisciplinary scientists to work together on experiments.<sup>48</sup> Of course, prosperity of sport events, improvement of communication technologies and transportation modes, etc. also contributes to the collaboration in sport sciences.

Many academic alliances have been established between universities and among countries, which breaks national boundaries through academic collaborations.<sup>49</sup> In spite of problems in knowledge products sharing, research alliances surely improved academic outputs.<sup>50</sup> This kind of academic alliance surely covers sports academic institutions. Meantime, increased frequency of sports conferences and meetings also provided more channels for communicating and collaboration between different countries' researchers.<sup>51</sup> This paper gets similar results with previous findings that there is a positive relationship between international collaboration and productivity in medicine.<sup>52</sup> Moreover, the share of international collaboration increases faster than the total academic outputs. So international collaboration has become the main driving force of growth of sport sciences research (limited to WoS data).

#### COLLABORATION PROPENSITY

“Collaboration propensity” means an individual researcher engaging in collaboration at a particular point in time and with regard to current research interests.<sup>53</sup> At the micro-level prospective, this tendency depends on multiple factors, like prior experiences of participants, institutional constraints, the availability of “attractive” collaborators in terms of influence or unique skills, or needs for access to special data or equipment.<sup>54-57</sup> At meso-level prospective, more and more inter-organizational alliances were founded in different countries.<sup>58</sup> The main purpose of alliances is to share their scientific and technological assets, and also to provide opportunities for researchers to collaborate.<sup>59</sup> At macro-level prospective, inter-units propensity is supported by national R&D policies or even supranational R&D policies.<sup>60</sup> Different economic, cognitive and social factors may shape the motives for research collaboration, and these vary by scientific fields and countries.<sup>61</sup> Interestingly, smaller countries tend to have higher levels of international collaboration.<sup>62</sup>

Previous results fit exactly our findings. In sport sciences, low-yielding countries, especially in European, normally have a higher level of international collaboration. There is no theory that could explain this phenomenon, which only could be understood as a consequence of the greater division of specialization, improvements in mobility and ICT, and the emergence of English as a world language in science.<sup>63</sup> It is also interesting that sport researchers showed strong tendency in collaboration. Finland, for example, different with other Nordic countries, prefers to collaborate with USA, similar to previous results.<sup>64</sup> In another case, South Africa has a tendency in collaboration with Australia, which is different from previous results.<sup>65</sup> But in the second period, South Africa has shifted his main partner from Australia to UK and USA, which is similar with previous findings on the overall scientific collaboration of South Africa. These results exhibit the traits of this discipline different from others or the overall.

If we take into account 29 country's continental properties, we will find that the strongest co-publication link happens between European countries and Oceanian countries, and it is bi-directional. For North America, Europe always is the most important partner, and Oceania is the second one. But for Asia, the co-publication links with other continents have not changed much between the two periods and Asia did not form such a dense collaboration network like Europe. Therefore, it is meaningful to explore the sociological reason behind collaboration propensity in sport sciences.

#### ASYMMETRY IN COLLABORATION

International co-authorship relations represent a large range of frameworks and motivations, extending from bilateral or even multinational programs to co-operation between individual scientists.<sup>34</sup> Bibliometric methods even could dig out the deep willingness of scientists to collaboration. Of course, this willingness is bilateral. That means one country maybe an active partner for another country, but it is not necessarily in turn. It is incapable to reflect any asymmetry present in symmetrical co-authorship analysis. So some researcher use two relative "importance" values to define the asymmetry relationship and called it "affinity".<sup>33</sup>

In this study, "affinity" values also tell sports scientists' one-way willingness to collaborate. The USA, as a central node of collaboration network, have a unilateral tendency of collaboration with European countries, while Far East countries all have a strong tendency of collaboration with the USA, which is similar with previous results that the USA are not an important partner for Europe but an important partner for Israel and some Far East countries.<sup>34</sup> Since the asymmetric collaboration willingness is always related to the USA, perhaps some relevant research results can provide some reference. (E. g., immigrant scientists are playing an important role in asymmetric international collaboration).<sup>66</sup> Coincidentally, results in unilateral collaboration intention

seem to have some similarities with the performance of international immigrations.

#### RELATIVE DECLINE OF ASIAN AND RISING OF NORDIC COUNTRIES

International collaboration does not always result in high citation impact. Nevertheless, most results are positive,<sup>43</sup> and only a few results were found with lower citation impact.<sup>67</sup> It seems that in this paper, there is a positive relationship between collaboration and citation impact in sport sciences and international collaborations broaden the audiences around this field. On the other hand, there is big difference of the gap in various countries between two periods. In Brazil, South Korea, Japan and Taiwan, there is a relative decline of the normalized index of citation impacts for international co-authored publications. First need to declare is that, in these countries, the number of international collaboration and citations to these publications are really growing while the share of international collaboration is below 41%, and the growth rate is lower than that of country's overall outputs. In contrast it is in the opposite trend in many western countries: international collaborated papers above 50% or even more, and the growth rate of international papers is higher than all outputs.

In many countries, publishing articles in international journals, especially journals included by SCI/SSCI, have become a paramount criterion to evaluate academic research output.<sup>68</sup> Contribution to journals with relative lower impact factor values seems to be a better choice for researchers in academic emerging countries given no requirements of journal IF. And at the same time, there is no interaction between authors publishing international papers and authors publishing domestic papers in these countries, like Turkey and Brazil.<sup>69,70</sup> These two reasons make it difficult to expand the audiences and get more citations.

In some western countries, especially the Nordic countries, exhibited an amazing performance as international partners. Previous study already showed that the Nordic is pas-

sionate about academic collaboration.<sup>33</sup> They always have strong co-authorship links with highly developed countries in West Europe and North America. The relatively greater number of professors and the larger number of foreign Ph.D. students in sport sciences are the basement of frequent international collaboration among Nordic countries.<sup>71</sup> Postdoctoral training, especially in strong academic institutions outside the Nordic countries like USA or UK, has become essential for a scientist to obtain an academic research position. From the perspective of world overall research investment and outcome, Denmark and Sweden have far higher R&D spending rates with higher numbers of researchers than other countries.<sup>72</sup> All these policies are encouraging researchers in this area to participate more in international collaboration.

## CONCLUSIONS

This analysis confirmed that the international collaboration has also strongly intensified in sport sciences in the last decade. The growth rate of international co-authored publications exceeds that of domestic ones. Sport sciences researchers show various collaboration propensity and asymmetric collaboration willingness in various countries. It is very meaningful to investigate the underlying motivation behind collaboration, especially social factors. Asian countries seem to lag behind other continents in terms of international collaboration. There is a positive relationship between international collaboration and attractivity of citations in sport sciences. Differences of impact performance between selected countries are in the fall. The Nordic countries, especially Denmark, have shown remarkable citation attractivity in international co-authored publications.

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## APPENDIX

	Australia		Canada		Germany		Netherlands		Switzerland		UK		USA	
Australia			1.82	2.30							2.80	1.79	0.81	0.64
Austria					15.68	8.88							1.68	0.91
Belgium													0.79	0.67
Brazil													2.29	1.11
Canada	2.30	1.82			1.20	0.90					1.53	1.18	1.44	1.20
Denmark														
Finland	3.86	3.31											1.49	1.10
France			1.49	1.86							1.19	1.15	0.58	0.51
Germany			0.90	1.20			2.75	3.98	6.35	11.28	1.12	1.16	0.66	0.63
Greece											9.88	5.75		
Ireland														
Israel													1.72	1.14
Italy											2.53	2.42	0.79	0.70
Japan			0.71	1.24									1.30	1.27
Netherlands					3.98	2.75					3.70	2.20	0.88	0.58
New Zealand	12.14	6.70											1.56	0.68
Norway														
P R China														
Poland														
Portugal														
South Africa	16.11	11.20												
South Korea														
Spain														
Sweden									5.99	9.16			0.89	0.73
Switzerland					11.28	6.35							0.98	0.52
Taiwan													1.19	1.30
Turkey														
UK	1.79	2.80	1.18	1.53	1.16	1.12	2.20	3.70					0.58	0.53
USA	0.64	0.81	1.20	1.44	0.63	0.66	0.58	0.88	0.52	0.98	0.53	0.58		

**Table 4.** Specific co-authorship affinity indicator values in 2000/01

	Australia		Canada		Germany		Netherlands		Switzerland		UK		USA	
Australia			1.55	1.31	0.92	0.73	1.15	0.95	0.89	1.18	2.10	2.20	0.86	0.56
Austria					6.85	5.35			4.89	6.40	1.30	1.28	0.98	0.63
Belgium	1.69	1.89					6.62	6.11			2.13	2.40	0.74	0.55
Brazil	0.75	0.98	1.10	1.20							0.70	0.92	1.49	1.27
Canada	1.31	1.55			0.94	0.89	1.28	1.26	1.24	1.97	0.99	1.19	1.35	1.60
Denmark	1.49	1.46			2.76	2.16			3.20	3.96	1.66	1.64	0.66	0.42
Finland													1.70	1.25
France	1.20	1.18	2.22	2.15					2.38	3.65	1.40	1.61	0.52	0.39
Germany	0.73	0.92	0.89	0.94			1.44	1.49	5.10	8.39	1.50	1.32	0.78	0.64
Greece											2.18	2.95	0.85	0.75
Ireland	4.41	3.53									3.77	3.30	1.10	0.58
Israel													1.51	1.37
Italy	0.63	0.72	0.69	0.66	1.33	1.2			2.56	3.89	2.53	2.89	0.7	0.52
Japan			0.86	1.91							0.39	1.40	0.75	1.31
Netherlands	0.95	1.15	1.26	1.28	1.49	1.44			2.31	3.74	2.27	2.76	0.83	0.66
New Zealand	7.59	6.60	2.19	1.47							2.32	1.86	0.74	0.39
Norway	1.80	1.50	1.26	1.30			2.39	1.93	3.19	4.16	1.81	1.78	0.95	0.61
P R China	2.22	2.74					2.72	2.77			1.39	1.72	0.92	0.75
Poland														
Portugal													1.73	0.92
South Africa											3.00	3.00	1.16	0.76
South Korea													1.31	1.82
Spain	0.74	0.77	0.94	0.82					1.16	1.60	1.34	1.4	1.00	0.68
Sweden	1.41	1.29	0.89	0.69	1.90	1.39			1.56	1.91	1.56	1.43	1.8	0.65
Switzerland	1.18	0.89	1.97	1.24	8.39	5.10	3.74	2.31			2.36	1.78	0.64	0.31
Taiwan													0.92	1.47
Turkey														
UK	2.20	2.10	1.19	0.99	1.32	1.50	2.76	2.27	1.78	2.36			0.71	0.46
USA	0.56	0.86	1.60	1.35	0.64	0.78	0.66	0.83	0.31	0.64	0.46	0.71		

Table 5. Specific co-authorship affinity indicator values in 2010/11

USA			UK			Canada			Germany			Australia			Netherlands			Switzerland		
Country	MOCR	MECR	Country	MOCR	MECR	Country	MOCR	MECR	Country	MOCR	MECR									
FI	6.85	3.86	DE	5.60	2.88	DE	6.45	3.60	AT	6.92	2.05	FI	6.90	4.16	US	3.67	3.32	SE	6.30	4.01
BE	6.00	3.72	IT	4.71	3.07	AU	5.03	2.68	CA	6.45	3.60	ZA	6.08	3.80	DE	3.30	3.50	US	3.88	3.47
DE	5.87	3.37	CA	4.55	2.78	US	5.01	3.78	US	5.87	3.37	US	5.27	3.27	UK	3.00	3.41	DE	3.59	3.03
AU	5.27	3.27	US	4.39	2.89	UK	4.55	2.78	UK	5.60	2.88	CA	5.03	2.68	NL	2.74	2.97	CH	2.40	2.41
CA	5.01	3.78	FR	4.00	2.92	JP	4.10	4.39	CH	3.59	3.03	NZ	4.16	2.61						
SE	5.00	3.62	AU	3.88	2.74	CA	3.05	3.09	NL	3.30	3.50	UK	3.88	2.74						
AT	4.93	3.90	NL	3.00	3.41	FR	2.58	3.17	DE	2.03	2.17	AU	2.97	2.90						
IT	4.91	4.01	UK	2.15	2.36															
UK	4.39	2.89	GR	0.83	1.85															
CH	3.88	3.47																		
JP	3.80	3.62																		
NL	3.67	3.32																		
FR	3.21	3.60																		
US	2.95	2.83																		
NZ	2.88	3.20																		
IL	2.00	3.14																		
TW	2.00	2.88																		
BR	1.18	3.51																		

**Table 6.** Co-authorship links and citation impact for seven selected countries in sport sciences ranked by mean observed citation rate (domestic values are set in italics; field impact in 2000/01=2.73)

USA		UK		Australia		Canada		Switzerland		Germany		Netherlands	
Country	MOCR	Country	MOCR	Country	MOCR	Country	MOCR	Country	MOCR	Country	MOCR	Country	MOCR
DK	21.14	DK	19.55	DK	20.75	DE	13.67	ES	15.20	DK	18.69	NO	16.30
SE	10.52	SE	12.30	DE	14.52	SE	13.09	NO	13.42	AU	14.52	AU	10.80
DE	9.39	CA	10.86	NO	12.92	NO	11.67	SE	13.00	CA	13.67	CA	9.57
AT	8.78	DE	9.34	IT	11.87	UK	10.86	AU	10.73	US	9.39	CH	8.29
UK	8.29	IE	9.30	ES	11.08	AU	9.79	DK	10.31	UK	9.34	US	7.31
ZA	7.85	NO	9.22	NL	10.80	IT	9.77	FR	9.41	IT	8.47	DE	6.82
BE	7.77	ES	8.93	CH	10.73	ES	9.69	CA	8.48	SE	7.50	UK	6.76
ES	7.62	ZA	8.43	CA	9.79	NL	9.57	NL	8.29	NL	6.82	CN	6.36
FR	7.55	US	8.29	BE	9.40	CH	8.48	AT	7.60	CH	6.00	BE	5.78
IT	7.35	IT	7.93	IE	9.32	US	7.16	IT	7.57	AT	3.87	NL	5.41
NL	7.31	AU	7.82	SE	8.64	FR	6.27	UK	7.28	DE	3.05		4.99
AU	7.27	AT	7.80	UK	7.82	NZ	5.00	US	6.34				
NO	7.21	CH	7.28	US	7.27	BR	4.60	DE	6.00				
CA	7.16	NL	6.76	FR	6.50	CA	4.07	CH	4.23				
GR	7.13	NZ	6.05	BR	6.23	JP	3.29		4.44				
IL	6.67	GR	5.76	AU	5.75								
CH	6.34	JP	5.58	NZ	5.09								
IE	5.21	FR	5.40	CN	3.19								
JP	5.11	CN	5.00										
NZ	5.03	BR	4.33										
FI	4.96	BE	4.26										
KP	4.54	UK	4.24										
US	4.29												
PT	4.25												
BR	3.93												
CN	3.88												
TW	3.50												

**Table 7.** Co-authorship links and citation impact for seven selected countries in sport sciences ranked by mean observed citation rate (domestic values are set in italics; field impact in 2010/11=4.38)