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Differing disciplinary citation concentration patterns of book and journal literature?

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ABSTRACT

A new data source providing the citation links of book publications, the Book Citation Index (BKCI), was recently released. A deeper understanding of the citation characteristics of book publications is needed before specific bibliometric indicators can be developed. In this study, the characteristics of citation distribution concentration in journal and book literature in Web of Science Core Collection (WoS), and the differences of these characteristics across fields, levels of aggregation and citation periods were probed to determine possible applications of this new data source for bibliometric studies. Even though the aggregation scheme is not sound for evaluation practices in books, aggregation matters much more for edited books in the sciences than for those in the social sciences and humanities. Journal articles have the least concentrated citation distribution in the sciences, while books play a more important role than other document types in the humanities. In the social sciences, both edited books and authored books have citation concentration distribution similar to journal articles. In addition, the Leimkuhler curves showed that citation window length (3 years vs. 9 years) does not affect the citation concentrations of most document types in journal and book literature significantly.

1. Introduction

The coverage of journal articles in the natural sciences and life sciences is relatively high in the Science Citation Index Expanded (SCIE). By contrast, the coverage of the Social Sciences Citation Index (SSCI) and the Arts & Humanities Citation Index (A&HCI) is too inconsistent to accurately represent the output of the social sciences and humanities in all countries (Hicks, 1999; Nederhof, Zwaan, De Bruin, & Dekker, 1989; Norris & Oppenheim, 2007). The general trend that can be observed from previous studies (Nederhof, Meijer, Moed, & van Raan, 1993; Butler & Visser, 2006; Sivertsen, 2009; Engels, Ossenblok, & Spruyt, 2012) is that the more important books are in a field, the less its literature is covered by WoS because of its restriction to journal literature contrary to the fragmented feature of works in the social sciences and humanities. The limited coverage of WoS will certainly lead to inaccuracies when standard bibliometric methods are applied to these fields. Studies investigating the citation characteristics of books considered either the citations of so-called non-source items in the references of WoS journal papers (Butler & Visser, 2006; Hammarfelt, 2011; Amez, 2013; Chi, 2014) or analyzed the citations in other alternative data sources such as Google Books or Google Scholar (Kousha & Thelwall, 2009; Kousha, Thelwall, & Rezaie, 2011; Samuels, 2011, 2013). However, large-scale bibliometric studies analyzing the citation patterns of

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book literature were rarely conducted during the last decades due to the lack of a reliable and comprehensive data source providing citation links.

The Book Citation Index (BKCI), a new collection in the WoS, was released by Thomson Reuters in 2011 to supplement the limited coverage of WoS. It allows users to discover book literature and trace its citation links alongside journal literature (Adams & Testa, 2011). BKCI covers over 60,000 editorially selected books starting from 2005 with an additional 10,000 new titles each year (Book Citation Index, 2015). After the release, some of its limitations already have been discussed in previous studies. For example, Gorraiz, Purnell, and Glänzel (2013) question the fuzzy boundaries of subtypes of books and how to treat new editions of works, and argue to distinguish the citations of an edited book and its book chapters since a global consensus on how to cite the book editor(s), the book author(s) or the author(s) of the book chapter is lacking. They also argue that 'book' might be considered to be at a higher hierarchical level than 'journal' instead of being treated as a document type in the system, and consequently point out the lack of cumulative citation counts from different hierarchies in BKCI. Even though it is possible to distinguish in the database between monographs and edited volumes among the type 'book', a normalization of the credit for a monograph depending on the document types is required (Leydesdorff & Felt, 2012). Additionally, problems from ignoring differences between book series and annual series were indicated by Leydesdorff and Felt (2012) and confirmed by Torres-Salinas, Robinson-García, Jiménez-Contreras, and Delgado López-Cózar (2012) and Torres-Salinas, Rodríguez-Sánchez, Robinson-García, Fdez-Valdivia, and García (2013).

With the new data source, a deeper understanding of books' citation characteristics is needed before bibliometric indicators can be developed, in order to adjust and adapt them appropriately to the bibliometric toolbox (Leydesdorff, 2009; Torres-Salinas, Robinson-García, Cabezas-Clavijo, & Jiménez-Contreras, 2014). One step toward this goal could therefore be comparing the citation distributions of journal and book publication groups, since the enormous inequality in researchers' productivity and the skewness of citation distributions are at the foundation of bibliometrics and most of the empirical laws in the field deal with the power law probability distributions of both publications and citations (i.e. Bradford's law, Zipf's law, Lotka's law and Price's law).

Many concentration measures, such as the Gini Index, the Leimkuhler curve, the Herfindahl–Hirschman Index and the Characteristic Scores and Scales, from different backgrounds have been used to investigate the bibliometric distributions for journal publications (e.g. Allison, 1974; Burrell, 1992; Egghe and Rousseau, 1990; Glänzel, 2007; Larivière, Gingras, & Archambault, 2009). For example, Allison (1974) found that the inequality of productivity of scientists assessed by the Gini index increased over time. For articles' citations decreases in the Herfindahl–Hirschman Index and the least percentage of papers for specific proportion citation over time were observed (Larivière et al., 2009; Yang, Ma, Song, & Qiu, 2010). Some constant features of citation concentration shown in different sample sets with different measures include the disciplinary differences and the independence of citation window length (cf. Allison, 1974; Glänzel, 2007; Larivière et al., 2009; Yang et al., 2010).

Following this framework, this study will investigate the citation concentration characteristics of both journal and book literature in the new WoS contents, and their differences across fields, levels of aggregation of publications and lengths of citation periods, to determine possible applications of different data sources for bibliometric indicators. The research questions of this study are as follows:

- Are citation distributions in book and journal literature comparable?
- Should citations to constitutive items of a book be aggregated at the book level?
- What is the influence of citation window length for book publications? What is the difference between citation concentrations with a long-term citation window (nine years) and with a short-term citation window (three years)?

2. Material and methods

2.1. Data sources

The complete 2005–2011 contents of the Web of Science Core Collection (WoS) including the three journal databases, SCIE, SSCI and A&HCI, as well as the BKCI have been processed as source documents. Overlap among proceedings, books and journals were excluded to obtain duplicate-free datasets. Citation counts were calculated from the 2014 version of WoS database of the Centre for Research & Development Monitoring (ECOOM), KU Leuven, which indexes 50,251 books and 30,058,730 journal papers in total.

2.2. Document type

Four document types were selected for further analyses at two comparison levels: books and articles. *Edited books* and *authored books* were compared with each other at individual and aggregated levels, while the document type 'Article' for *book chapters* and *journal papers* was used because of its central importance. Table 1 shows the detailed terms of each document type.

1) Books

Since citations to individual chapters could not always be identified when they were assigned to the edited book in the citing documents (Chi, Jeuris, Thijs, & Glänzel, 2015), the citation count of an edited book was not divided by the number of

Table 1
Data definition of each document type.

	Book Publications								Journal Publications	
	Edited Book			Authored Book			Book Chapter		Journal Article	
Counts	Books 14,416	Subitems 261,338	Citations 167,558	Books 19,520	Subitems 213,180	Citations 97,261	Articles 427,294	Citations 143,889	Articles 6,918,967	Citations 33,271,440
Document type	(Book ⋂ any type) ⋃ (Book Chapter ⋂ any type)						Book Chapter ⋂ Article		Article	
Publication type	(Books in series ⋃ Books) ø Journal						all		all	
Edition[a]	(BSCI ⋃ BHCI) ø (SCI ⋃ SSCI ⋃ AHCI ⋃ ISTP ⋃ ISSHP)								(SCI ⋃ SSCI ⋃ AHCI) ø (BSCI ⋃ BHCI ⋃ ISTP ⋃ ISSHP)	
Publication year	2005–2011									

Data sourced from Thomson Reuters Web of Science Core Collection.
[a] BSCI and BHCI are the science and the social sciences & humanities editions of BKCI. ISTP (Index to Scientific and Technical Proceedings) and ISSHP (Index to Social Science and Humanities Proceedings) are the two editions of Conference Proceedings Citation Index (CPCI).

Table 2
Sample sizes in four selected fields (2005–2011).

Field	Book Publications			Journal Publications
	Edited Book (%)[a]	Authored Book (%)[a]	Book Chapter (%)[a]	Journal Article (%)[a]
Biosciences	839 (4.2%)	168 (0.7%)	18,686 (3.2%)	624,489 (6.8%)
Chemistry	973 (4.8%)	574 (2.2%)	21,807 (3.7%)	1,327,150 (14.6%)
Arts & Humanities	2,787 (13.9%)	7,879 (30.8%)	109,212 (18.7%)	245,568 (2.7%)
Social Sciences II	3,670 (18.3%)	5,686 (22.2%)	101,608 (17.4%)	231,064 (2.5%)

Data sourced from Thomson Reuters Web of Science Core Collection.
[a] Percentage of the publications in a given field among all fields.

its chapters in this study to give a fractional count of whole-work citations to its chapters. Instead, I retrieved the publications and citations of all the books in BKCI which are not indexed in SCI/SSCI/AHCI and Conference Proceedings Citation Index (CPCI) from 2005 to 2011, including the book main records themselves (i.e. records with “Book” as document type in BKCI) and all the chapters belonging to them. In contrast, the book itself (single item of a book record) was analyzed in this study as well to detect the role of book records as a citation unit in research evaluations. A 3-year citation window is applied here. In order to avoid the influence of periodical books (e.g. annual review serials), I excluded those items having the publication type ‘Journal’, which are indexed in both SCI/SSCI/AHCI and BKCI. Note that 1458 books are excluded because their chapters are indexed in SCIE/SSCI/AHCI while their book records are exclusively indexed in BKCI.

After defining the scope of books, the second step was to distinguish between *edited books* and *authored books*. All the records with editor but no author data were assigned to *edited books*, while records with only author data were coded *authored books*. An additional criterion for *edited book* is that an *edited book* should have more than one item (i.e. at least one book chapter apart from book item), thus two yearbooks were excluded. 2457 books without editor or author data, and 557 books with both editor and author data were excluded in this study.

2) Book chapter articles

This study collected all book chapter items published from 2005 to 2011, which are designated as ‘Article’ and ‘Book Chapter’ document types in BKCI for publications of *book chapter articles*. The citations they received within 3 years after publication were calculated.

3) Journal articles

SCI/SSCI/AHCI journal papers which are assigned the document type ‘Article’ in WoS published from 2005 to 2011 were retrieved as *journal articles*. Their citations were calculated with a 3-year window.

2.3. Field classification

All the publications were classified into 16 research fields and 74 subfields based on their ISI subject categories according to the modified Leuven-Budapest classification scheme (cf. Chi et al., 2015; Glänzel & Schubert, 2003), except for the publications in five inter-disciplinary categories (Audiology & Speech-Language Pathology, Cell & Tissue Engineering, Ergonomics, Logic, Nanoscience & Nanotechnology). In this paper, four major fields were selected to represent different areas of the sciences, the social sciences and humanities: BIOSCIENCES (B) with the highest average citation rates in all document types (except for MULTIDISCIPLINARY SCIENCES), CHEMISTRY (C) with the top total numbers and citations of journal articles, ARTS & HUMANITIES (K) with the top total numbers of book chapters, and SOCIAL SCIENCES II (ECONOMIC, POLITICAL & LEGAL SCIENCES) (L) with high total number of citations of book chapters.

The sample sizes in the selected major fields are listed in Table 2. The distinct numbers of different categories indicates the coverage and selection process of WoS: much more books in the social sciences and humanities (SSH) are indexed than in the biosciences and chemistry, while the number of journal articles in these sciences is higher than those in the SSH. In

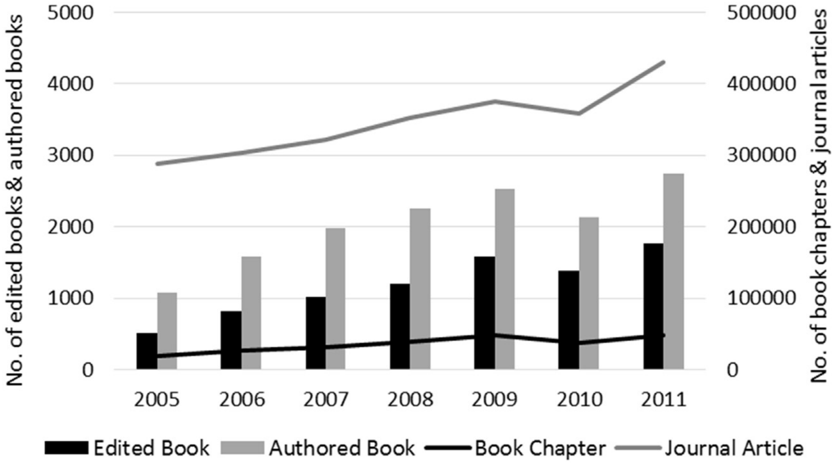

Fig. 1. Numbers of WoS publications in four fields by publication year.
Data sourced from Thomson Reuters Web of Science Core Collection.

general, the yearly volumes of both document types in Fig. 1 show an increasing trend of coverage the database, except for in 2010 with less publications than earlier and later years.

3. Calculation

The following indicators were applied to the 2005–2011 WoS publications with a 3-year citation window to analyze the characteristics of the publication groups. The first three indicators assess the general features based on the citations and publications distributions of different groups, while the last four indicators probe the dimension of citation concentration in the analyzed targets.

3.1. General indicators

1) Publication growth rate

The overall growth rate of publications is calculated by the division of the different numbers of publications after seven years and the amount of the publications in 2005. Similarly, the annual growth of the numbers of publications is calculated by the division of the difference between the publications of a year and the year before and the amount of the publications of the earlier year. The rates are applied to check for differences in the growth dynamics or coverages between book and journal items across fields.

2) Average citation rate

The ratio of the total number of citations received by publications in a given field or year to the total number of those publications. For aggregated books, their average citation rates are divided by the number of all sub-items instead of the number of the volumes, because the purpose of this indicator is to find the mean of the individual items' citation counts.

3) Uncited rate

The ratio of the number of publications which are never cited after being published to the number of publications in a given field and/or year. Unlike the last indicator, the denominator of aggregated books here is the number of their volumes instead of the number of whole items.

3.2. Concentration indicators

Based on the studies mentioned above, this study made use of four common indicators of the degree of citation concentration. The Gini coefficient and the Leimkuhler curve, which are essentially cognate, were both adopted to facilitate the numerical and graphical comparison of concentration from the same analytical approach. To include measures from other theoretical conceptions of concentration, the Herfindahl–Hirschman Index and concentration ratios were applied as well.

1) Gini coefficient

The Gini coefficient (Gini, 1912; Bellù & Liberati, 2006; Ceriani & Verme, 2012) measures the inequality among values of a frequency distribution (e.g. incomes in economics, or numbers of citations in this paper). It can be defined as a ratio of the areas on the Lorenz curve (Lorenz, 1905) diagram, which plots the cumulative distribution function of the empirical probability distribution of income in economics. It could therefore be clearly interpreted geometrically and is sensitive to all areas of the distribution (Allison, 1974). If the area between the line of perfect equality (the diagonal) and the Lorenz curve is A, and the area under the Lorenz curve is B, then the Gini coefficient is $G = A/(A + B)$. The Gini coefficient can theoretically range from 0 (complete equality) to 1 (complete inequality); the higher Gini coefficient, the more unequal is a frequency distribution.

The index has been connected to the field of bibliometrics since Carpenter (1979) drew the attention to the similarity of Pratt's (1977) measure of class concentration in bibliometrics to the Gini coefficient and got Pratt's (1979) confirmation that his measure C is virtually identical to the Gini coefficient. According to Allison (1980), Britton (1964) noted a more unequal distribution of publications summarized by the Gini index than that of personal income. In the 1990's bibliometricians investigated the possibility of using other measures of concentration and found that the Gini coefficient performs well in the field (Burrell, 1992; Egghe, 1992; Egghe & Rousseau, 1990; Rousseau, Van Hecke, Nijssen, & Bogaert, 1999). Afterwards the Gini coefficient was applied to measure the unevenness of citation distribution or informetric productivity for different units such as journals, universities and countries in bibliometric studies (e.g. Stegmann & Grohmann, 2001; Guan & Ma, 2007; Leydesdorff & Rafols, 2011; Lopez-Illescas, de Moya-Anegon, & Moed, 2011).

2) Herfindahl–Hirschman Index

The Herfindahl–Hirschman Index (Herfindahl index, HHI) is a commonly used measure of the concentration of firms in a given market. The index was developed independently by the economists Hirschman (1945) and Herfindahl (1950), see Hirschman (1964). It is based on the sum of squares of firms' market shares within the industry. The result is proportional to the average market share, ranging from 0 to 1. A higher HHI indicates a more concentrated market. As the market concentration increases, competition and efficiency decrease and the chances of collusion and monopoly increase.

While applying HHI in bibliometric studies, the size of the market is replaced with the sum of the number of citations received by each individual paper, and the market shares are replaced with the number of citations received by each paper divided by the total number of citations received by papers published the same year. (Evans, 2008; Larivière et al., 2009)

Like the Gini coefficient, the Herfindahl-Hirschman Index measures the unevenness of (citation) distributions but from a different perspective. It gives more weight to larger players, revealing the market concentration or competition among them. The HHI is therefore the most sensitive concentration index among the four indices (Gini's, Bonferroni's, Amato's, and Hirschman-Herfindahl's) in contexts where Zipf's law applies (Naldi, 2003).

3) Concentration ratio (CR(n))

In economics, a concentration ratio is a measure of the total output produced in an industry by a given number of the largest firms in the industry, showing the extent to which the largest firms contribute to activity in the industry (Mahajan, 2006). For example, CR5 means the percentage of market share held by the largest five firms in an industry. Concentration ratios and the HHI are standard tools to measure market concentration. The concentration ratios just provide a sign of the oligopolistic nature of an industry, whereas the HHI provides a more complete picture of industry concentration than does the concentration ratio.

In this study, the concentration ratio is applied to bibliometric analyses for the first time. Apart from the top citation contributors, this study also shifts the focus of this indicator from a few most cited publications to a wider range of targets, which means taking a certain percentage of top publications instead of a specific number of top publications as the threshold. Therefore, CR(5), CR(10) & CR(50) as well as CR(5%), CR(10%) & CR(50%) were applied in this study to measure the citation concentration of scientific publications.

4) Leimkuhler curve

Leimkuhler (1967) derived a mathematical form for the Bradford distribution, $f(x) = ln\left(1+\beta x\right)/ln\left(1+\beta\right), 0 \le x \le 1$, depending on a single parameter interpretable from the verbal formulation of Bradford's law. The Leimkuhler curve plots the cumulative proportion of total productivity against the cumulative proportion of sources (Burrell, 2006; Egghe, 1990, 2005). Leimkuhler's approach is considered as a variant of the Lorenz curve of concentration for bibliometric data (Burrell, 1991, 1992; Rousseau, 1994). The difference between the two constructions is only the sorting order of the values (Burrell, 2005; Sarabia, 2008).

3.3. Citation windows

After the first analysis with the above indicators, the aging issue in different fields will be further examined. To investigate the impact of the different lengths of citation periods on citation concentrations, both a long-term (nine years) and a short-term citation window (three years) were applied to the WoS publications of 2005 only. The ratio of average citation rates with these two citation windows was then calculated as a prospective Price index and an indicator of ageing (see Chi et al., 2015). Furthermore, through the Leimkuhler curves the influence of different lengths of citation periods in different fields can be shown.

4. Results

4.1. General

4.1.1. Publication growth rate

In Fig. 2, the overall growth rates of *edited books* and *book chapters* are relatively larger than those of *authored books* and *journal articles*, especially in Biosciences. The growth of all kind of publications in Social Sciences II is also remarkable comparing to other fields. Similarly, the yearly growth of journal publications in WoS is much more stable than that of book

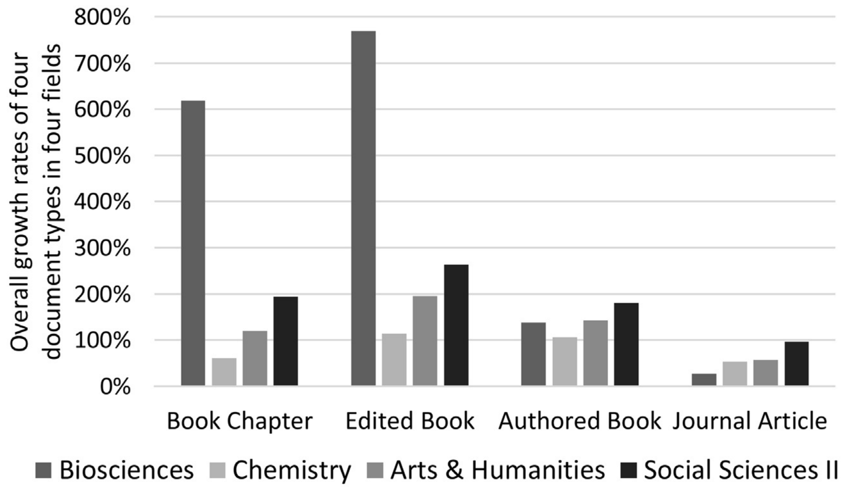

Fig. 2. Overall growth rates of WoS publications in four fields (2005–2011).
Data sourced from Thomson Reuters Web of Science Core Collection.

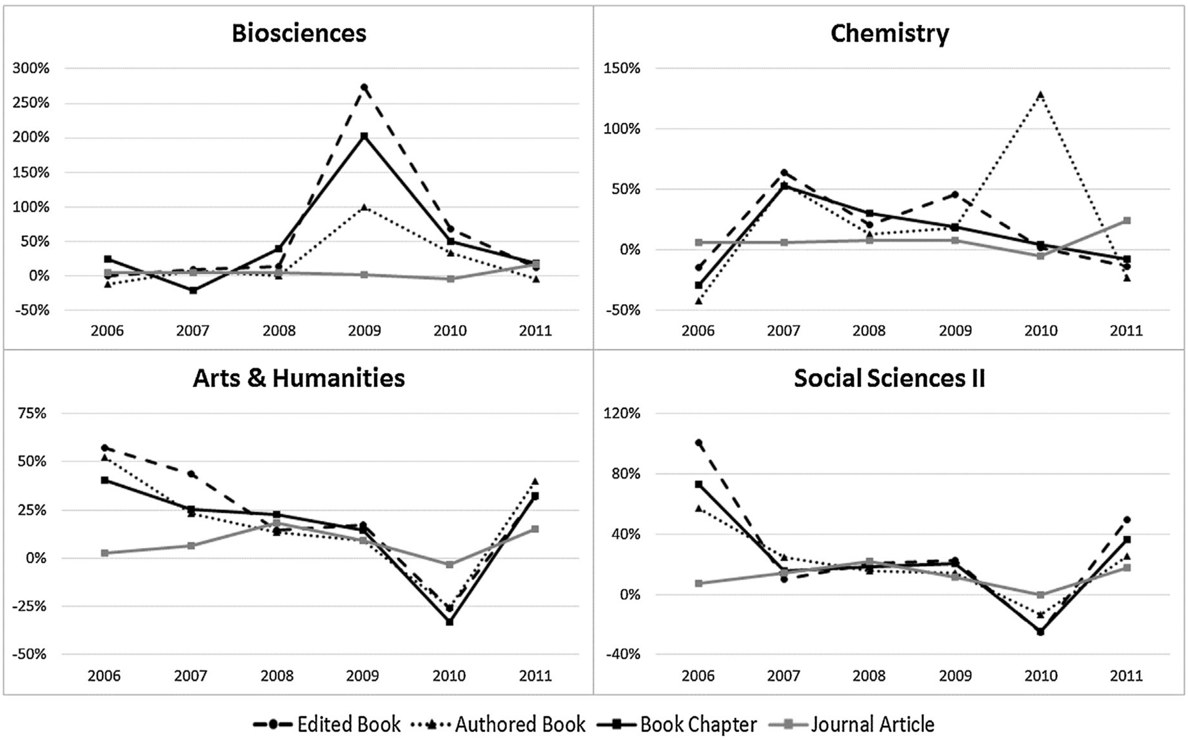

Fig. 3. Annual growth rates of WoS publications in four fields (2005–2011).
Data sourced from Thomson Reuters Web of Science Core Collection.

publications as shown in Fig. 3, especially in natural sciences. The growth of volumes of *journal articles* is steady during the seven years, with a larger growth in the last year. Moreover, *journal articles* in Social Sciences II and Arts & Humanities have their peaks in 2008.

Books and *book chapters* have relatively turbulent and varied growth curves compared to *journal articles*. The small total number of *books* and *book chapters* may cause this fluctuation. The irregularities of *books* and *book chapters* in Fig. 3 may reveal a different time series of the development of BKCI publications in the SSH and natural sciences. The three book related categories in Biosciences and Chemistry are largely indexed into BKCI later than those in the fields Social Sciences II and Arts & Humanities are. According to the whole data set in this study, the three SSH fields (Arts & Humanities, Social Sciences I and Social Sciences II) have the largest increase of books in BKCI in 2006, then Chemistry, Engineering, Physics and Geosciences & Space Sciences have their largest increase in 2007; Agriculture & Environment, Biosciences, Biology, Biomedical research,

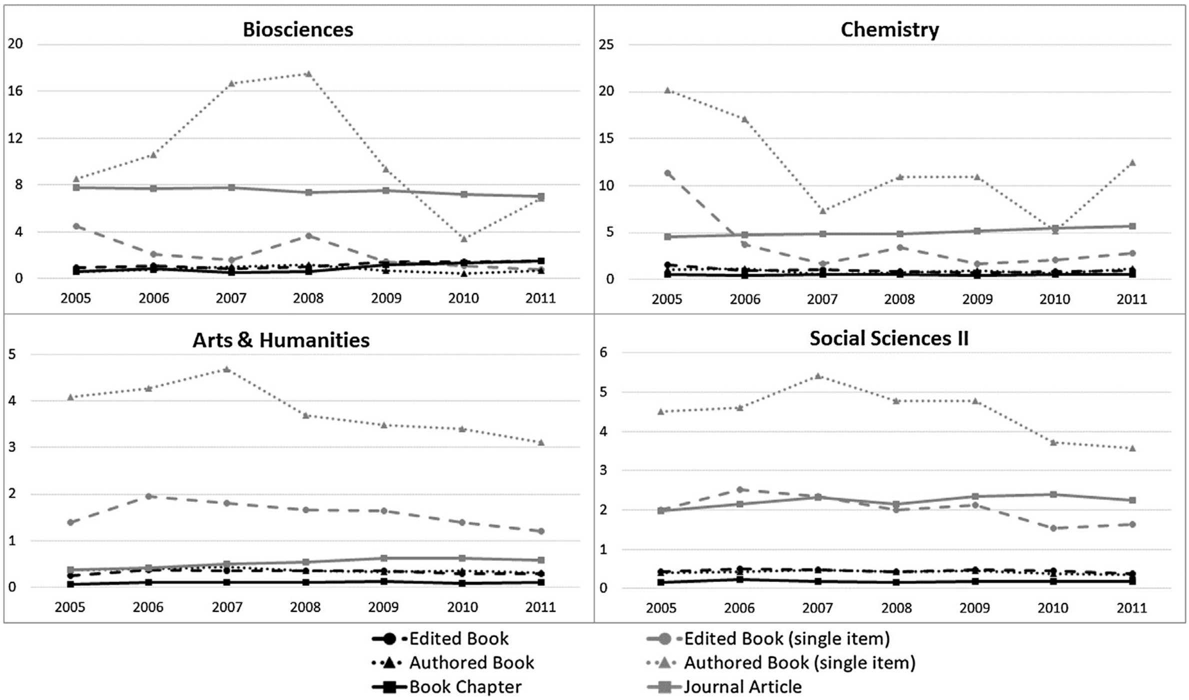

Fig. 4. Average citation rates of WoS publications in four fields (2005–2011).
Data sourced from Thomson Reuters Web of Science Core Collection.

Clinical & Experimental Medicines I & II burst in 2009. These peaks indicate that BKCI may have focused on SSH book publications in the beginning of the project, and then switched the indexing focus to different fields, from basic sciences to life sciences sequentially.

4.1.2. Average citation rate

Fig. 4 shows a general pattern across fields: *journal articles* have higher impact than *book chapter articles*, while the individual book records have higher impact than the whole books. The individual *authored books* have the highest citation impact among all the document types, while *book chapters* have the lowest impact. It is also interesting that individual *authored books* have higher citation impact than individual *edited books* across all fields.

Apart from the general pattern across fields, the distinct patterns in different fields are noteworthy. After normalizing the citation rates of different document types in a field, the high citation impact of individual books is especially shown in the SSH fields, corresponding to the results that "individual books (but not chapters) tend to be more often cited than articles" in modern language and literature research (Nederhof, 2011). In Fig. 4, Biosciences and Chemistry have higher cited rates in individual *authored books* and *journal articles*. In contrast, in Social Sciences II the impact of *journal articles* drops down to the level of individual *edited books*, and in Arts & Humanities it is even lower than individual *edited books*. This is in line with the results reported in Broadus (1971) and Glänzel and Schoepflin (1999) that books are much less often cited in chemistry and physics than the SSH according to the shares of references to books.

4.1.3. Uncited rate

The publications in Social Sciences II and Arts & Humanities have smoother uncited rates of different document types over seven years than those in Biosciences and Chemistry as shown in Fig. 5. The patterns of the uncited rate in Arts & Humanities are the most diverse. In the SSH, *journal articles* are more rarely cited, and the differences between individual and whole *edited books* are smaller than the sciences. The latter observation may imply that *edited books* in the sciences have more sub-items in each volume, and scientists compared to scholars in the SSH would cite a specific chapter rather than the edited book itself. More details will be examined in Section 5.

In general, individual books are cited less frequently but have higher average citation rates (cf. Fig. 4 and Fig. 5), even though the uncited rates between individual and whole *authored books* are not distinct at all in all fields. There is a marked difference between *authored books* and *edited books*. *Authored books* have less chapters than *edited books*, so the influence of aggregation scheme is less in *authored books* and their individual books have higher impact. In Biosciences the increase of uncited *authored books* in the last two years is an interesting exception since other life sciences also have the same increasing uncited rates.

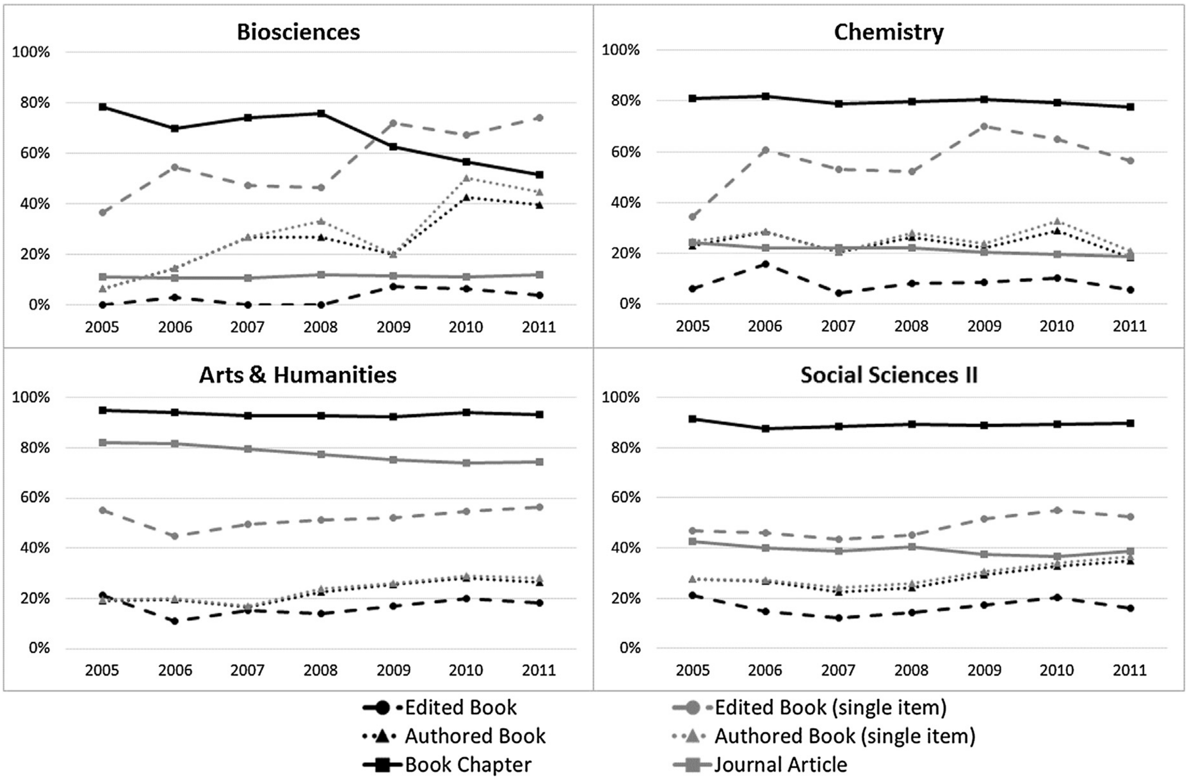

Fig. 5. Uncited rates of WoS publications in four fields (2005–2011).
Data sourced from Thomson Reuters Web of Science Core Collection.

4.2. Concentration degree

4.2.1. Gini coefficient

The Gini coefficient patterns in Fig. 6 are similar to those of the uncited rates in Fig. 5. The similar pattern more or less reveals the strong effect of the uncited rate on the calculation of Gini coefficient, especially in the SSH. Similar to the uncited rates in Arts & Humanities, the subfigure of the Gini coefficient in Arts & Humanities in Fig. 6 is distinct from those in other fields.

The citation distributions of *book chapters* are more unequal than those of *journal articles*, since *book chapters* have higher uncited rates and lower average impact than *journal articles*. Aggregated *edited books* have more equally distributed citations than individual *edited books*. The gaps between aggregated and non-aggregated *edited books* are specially larger in the sciences than the SSH. For *authored books*, both aggregated and non-aggregated books display similar citation distribution equality as shown in uncited rates.

4.2.2. Herfindahl–Hirschman Index

In line with Gini, *book chapters'* citations are distributed more unequal than those of *journal articles* in Fig. 7. *Journal articles* have the lowest concentration in terms of HHI in all the fields. Compared to articles, books lack the consistency of HHI patterns across fields. In the sciences, *authored books'* citation distributions are more unequal than *edited books*, and vice versa in the SSH, especially in Arts & Humanities. The effect of aggregation scheme applied to books in Fig. 7 are in line with the Gini patterns in Fig. 6. First, aggregated and non-aggregated *authored books* keep the cognate citation distribution equality in all fields as shown in Gini and uncited rates. Second, individual *edited books* are more unequal than the whole *edited books*. Third, the distances between these two groups in sciences are larger than those in the SSH.

The dissimilar results of these two concentration indicators appear in the comparison of books and book chapters. Books are more concentrated than book chapters in terms of HHI, but have more equally distributed Gini patterns than book chapters. The results show that the general citation evenness of books is larger than that of chapters, but the individual difference among books (specially the disparity caused by few monopolists) are larger than book chapters. We can thus picture a more equal citation distribution in general but with bigger individual differences among books than individual chapters.

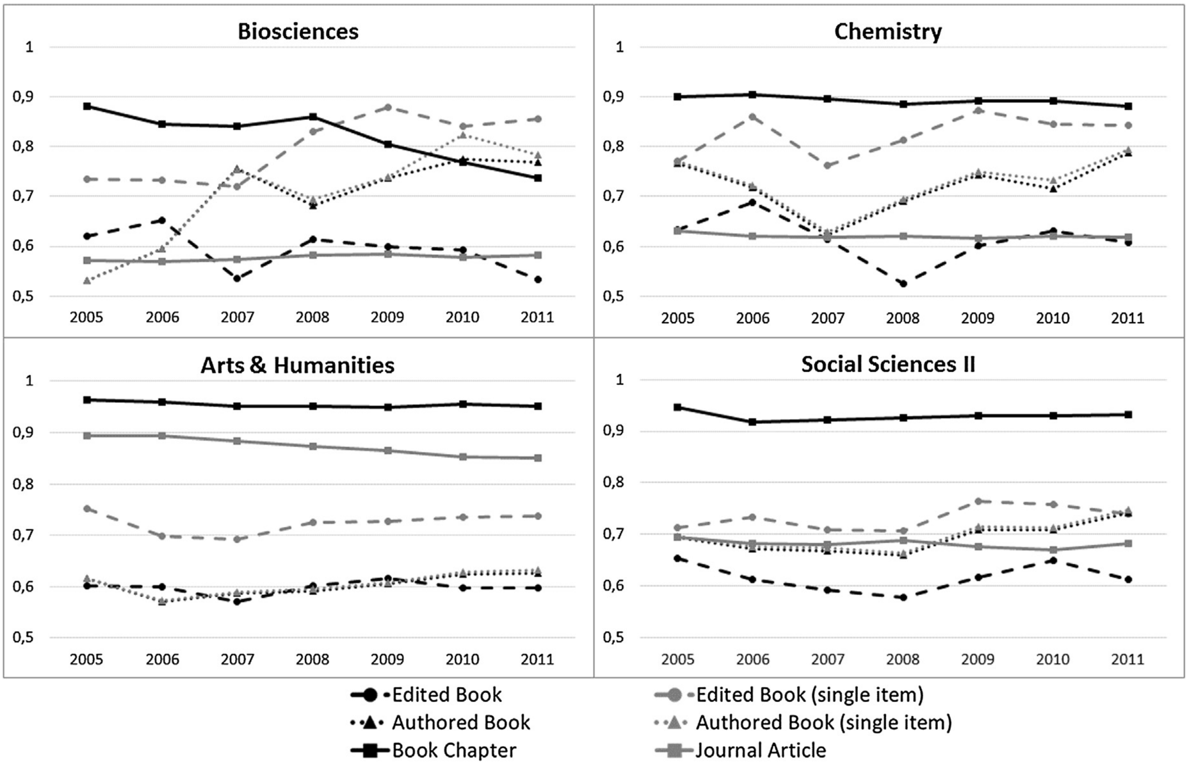

Fig. 6. Gini coefficients of citations of WoS publications in four fields (2005–2011).
Data sourced from Thomson Reuters Web of Science Core Collection.

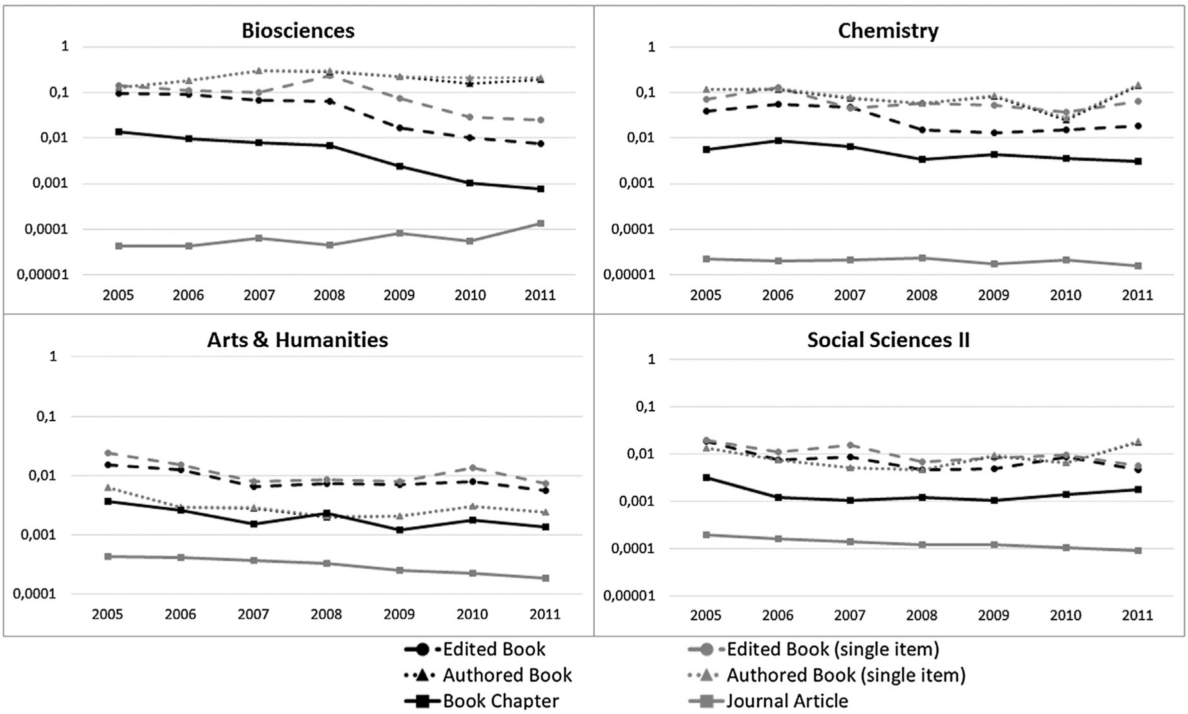

Fig. 7. Logarithmic Herfindahl indices of citations of WoS publications in four fields (2005–2011).
Data sourced from Thomson Reuters Web of Science Core Collection.

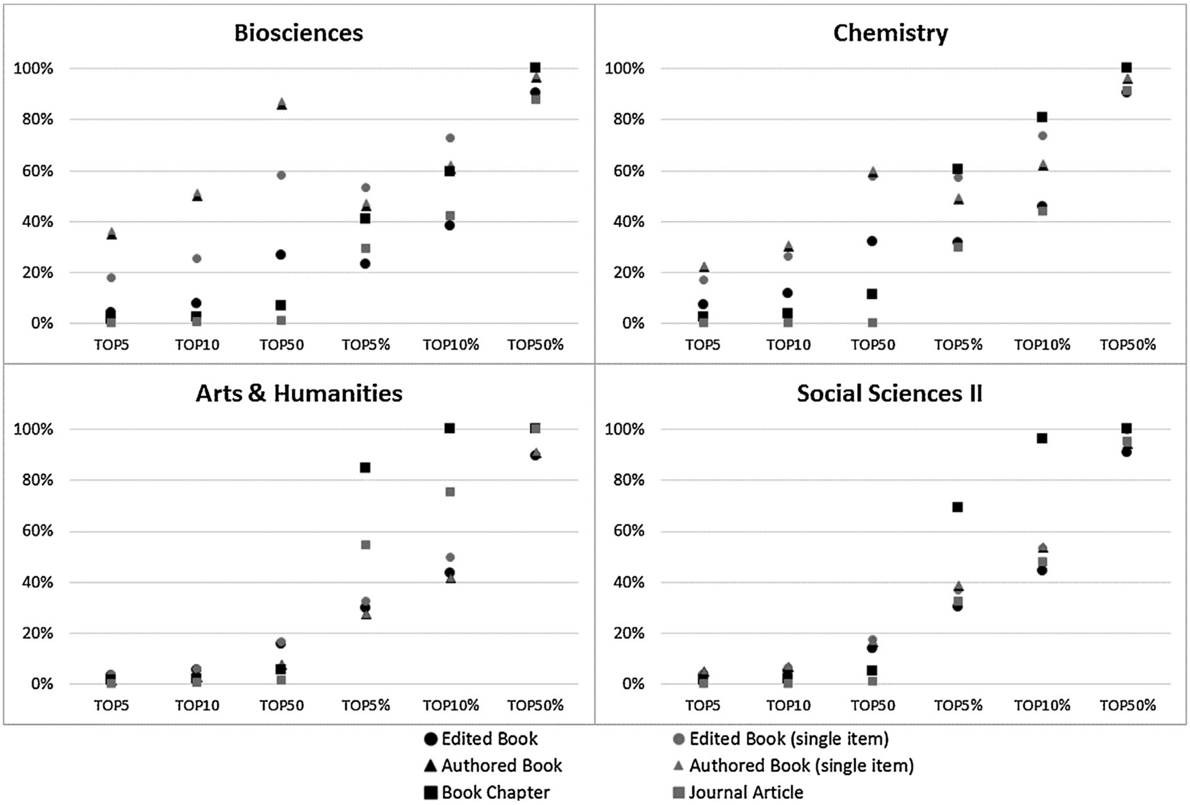

Fig. 8. Concentration ratios of citations of WoS publications in four fields (2005–2011).
Data sourced from Thomson Reuters Web of Science Core Collection.

4.2.3. Concentration ratio

Two types of concentration ratio considering a specific number and a percentage of top cited publications were both probed in this section and show different patterns among different document types across fields. The distribution of the concentration ratios of the specific numbers of top cited publications shown in Fig. 8 mirrors that of Herfindahl indices in Fig. 7 while the right-half part of Fig. 8, taking into account the percentage of top cited publications, is similar to the Gini coefficients in Fig. 6. The concentration ratios of the amounts of top cited book publications in Biosciences and Chemistry are much more concentrated than the SSH, reflecting the influence of a smaller pool of the book data set in the sciences.

The concentration ratios of the percentage of top cited publications could lower the above influence of dissimilar sample sizes. The top cited 50% of publications in all document types contribute to around 90–100% of total citations in four fields, showing a high concentrated citation distribution in general. The detailed differences across types and fields can be only revealed by CR(5%) and CR(10%). These two indicators distinguish a more monopolistic concentration of *book chapters* in the SSH from that in the sciences. Furthermore, the differences between the concentration of whole *edited books* and individual *edited books* are especially obvious in the sciences. This is in line with the result reported in the Gini and uncited rate sections. *Authored books* still show similar concentration rates between two groups (aggregated and non-aggregated) as the other two concentration indicators. Among four fields, Arts & Humanities is the most distinct field, having the highest concentrated *book chapters* and *journal articles* but the most equally distributed *authored books* in terms of citation concentration rates.

4.2.4. Leimkuhler curve

The Leimkuhler curve essentially confirms the implications of some other indicators shown before in one graph. First, the Leimkuhler curves shown in Fig. 9 reflect the Gini coefficients in each field and are also influenced by the uncited rates due to the formula design. The Leimkuhler curve provides a graphical concentration comparison while the Gini index gives a numerical value to the comparison (Burrell, 1991). Second, the Leimkuhler curves could be seen as the drawing lines of the consecutive concentration ratios of citation percentages. Therefore, Fig. 9 provides an intuitive perspective on the citation concentrations of different document types in different fields to support those single numbers in Fig. 5, 6 and 8 (TOP5%, 10%, 50%).

The biosciences have the most closely aligned curves among different document types in terms of the normalized citation accumulation (i.e. Leimkuhler curves in Fig. 9), followed by chemistry and the social sciences. In terms of document types, only the curve of *book chapters* is differentiated from the other three types with divergent degrees of difference in these three

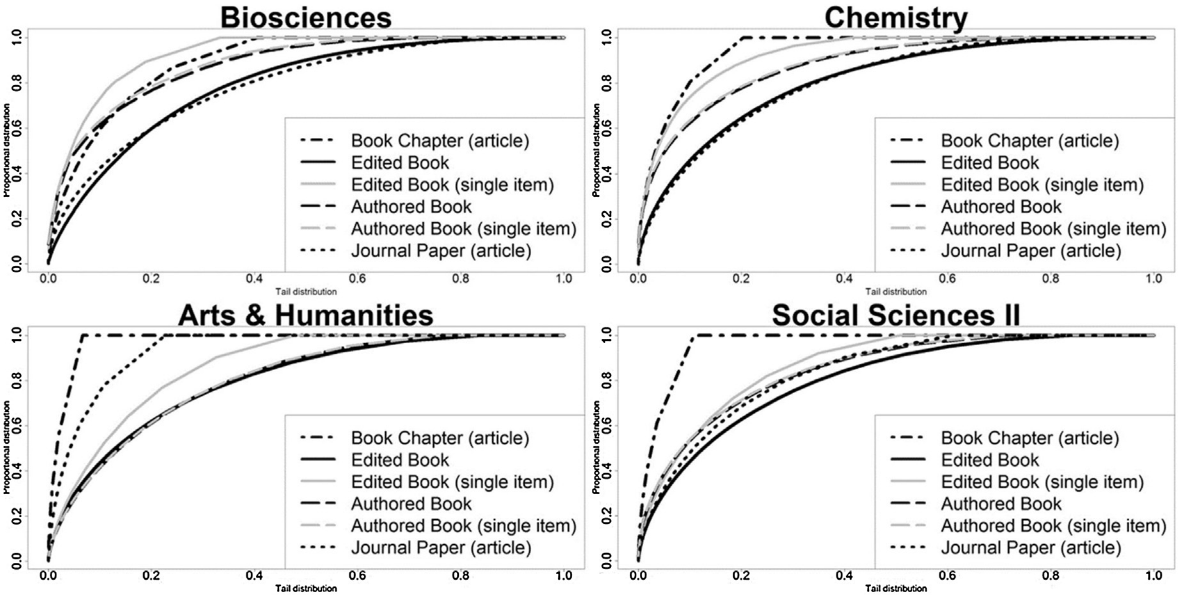

Fig. 9. Leimkuhler curves of citations of WoS publications in four fields (2005–2011).
Data sourced from Thomson Reuters Web of Science Core Collection.

fields. In contrast, arts and humanities have the most distinct patterns of their citation accumulations. The curves reveal the inconsistent citation concentrations among different document types in this field.

In the other three fields, the high uncited rates of *book chapter* distinguish their Leimkuhler curves from the other document types. Furthermore, the Leimkuhler curves of the aggregated *edited books* in the sciences are more comparable to *journal articles* than *authored books*. In Social Science II, *journal articles* and *authored books* have very similar Leimkuhler curves, and are not far from the curve of aggregated *edited books*, which have the highest evenness. Taking these two results into account, the outlier issue in *authored book* units may be more serious in the sciences.

In terms of the difference of the citation concentration distribution between single books and the entirety of their individual items, Fig. 9 shows obvious different patterns in *edited books* across fields. The differences between single items of *edited books* and aggregated *edited books* in the sciences are larger than those in the SSH, which are not so distinctive. However, single items of *authored books* and aggregated *authored books* have no striking different citation distributions in all fields.

4.3. *The influence of citation windows*

4.3.1. *Average citation rate*

From the perspective of citation accumulation, the average citation rates of all the document types in the four fields with a longer citation window are all unsurprisingly larger than those with a shorter citation window. Fig. 10 presents the ratios of average citation rates of different document types with two citation periods in four fields. In Biosciences and Chemistry, *book chapters* and *journal articles* have higher ratios of average citation rates with a three year citation window to those with a nine year citation window than the SSH, showing a rapid citing culture of these document types in the sciences. *Authored books* in these fields are cited relatively slower than other document types.

4.3.2. *Leimkuhler curve*

From the other perspective of citation distribution, Fig. 11 shows that the influence of the longer citation period is not significant on the citation concentration in the most fields. In Fig. 11 only the whole books instead of individual books are illustrated, since the differences of two citation periods between aggregated and non-aggregated books are not far-off in all the cases. The longer citation window changes the Leimkuhler curves of *book chapters* significantly, especially in Arts & Humanities. The longer citation period also affect the citation concentration of *authored books*, especially in Biosciences. It is interesting to note that in the SSH the citation concentration of *authored books* are more uneven with a longer citation window than with a shorter window. In contrast, the curves of *edited books* with different citation periods are much more similar than *authored books*. *Journal articles* in all four fields have almost identical curves for the two citation periods. Generally, Fig. 11 reveals that a citation window longer than three years does not affect the citation concentration of *journal articles* and *edited books* so much, but improves the stability of citation concentration of *book chapters* the most.

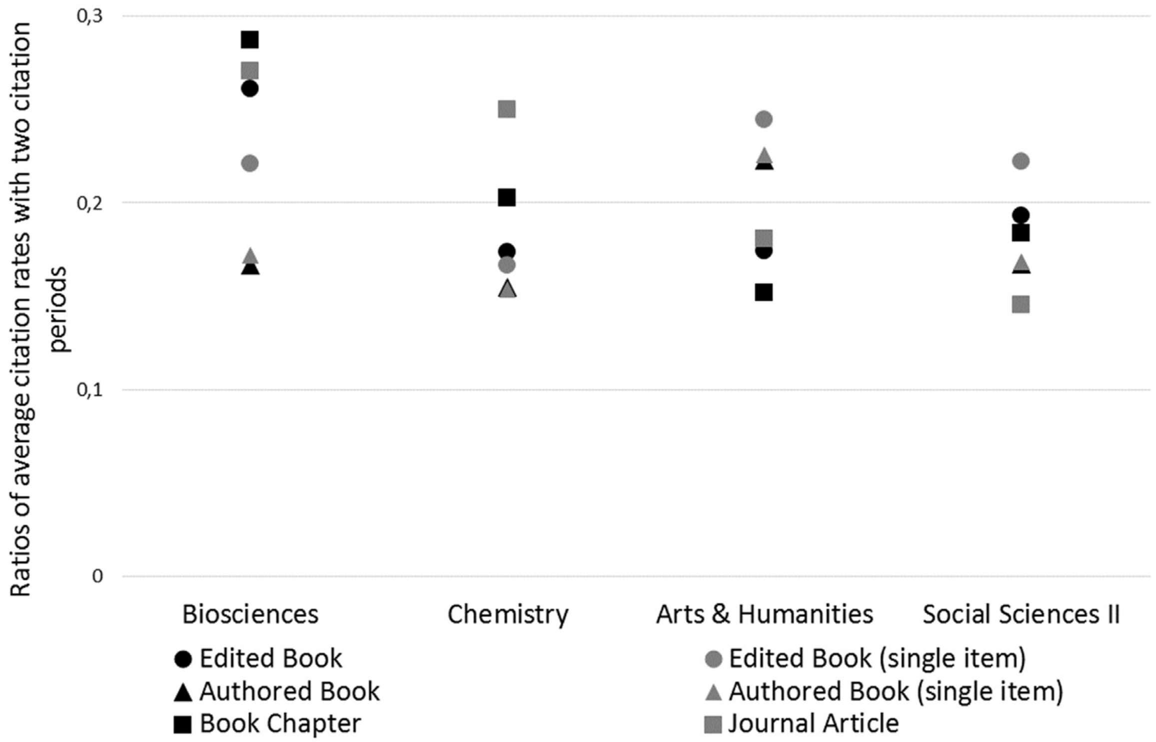

Fig. 10. The ratios of average citation rates with short and long term citation windows of different document types in four fields. Data sourced from Thomson Reuters Web of Science Core Collection.

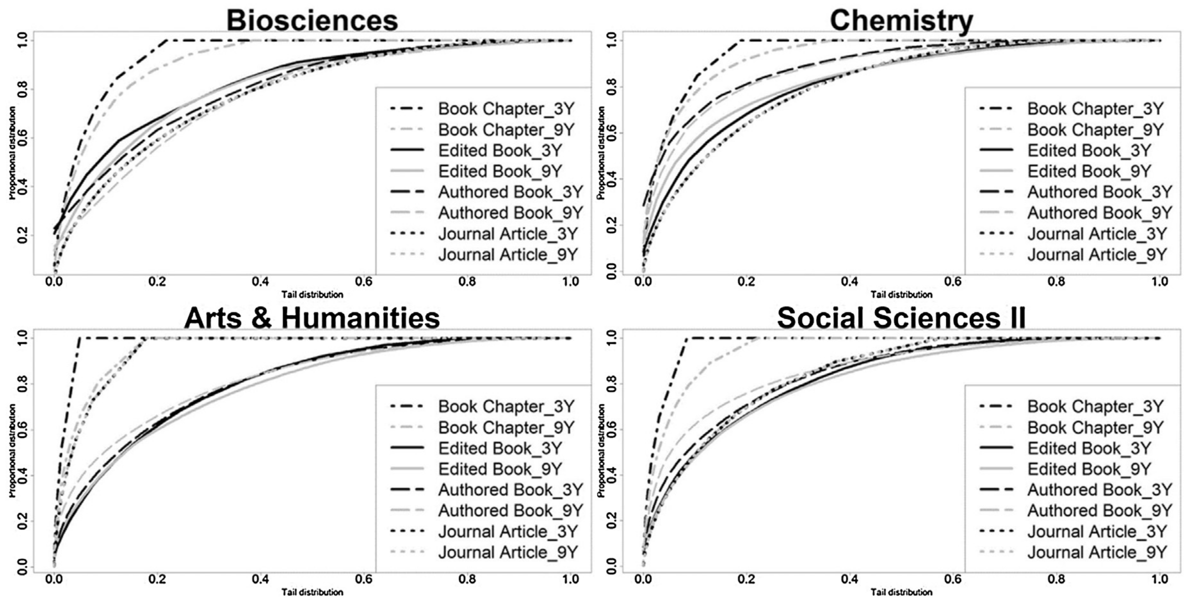

Fig. 11. Leimkuhler curves of citations of WoS publications in four fields with 3-year and 9-year citation windows (2005). Data sourced from Thomson Reuters Web of Science Core Collection.

5. Discussion

The main results will be discussed from four perspectives in this section: document type, field, concentration index and citation window.

5.1. Document type

5.1.1. Books

Three dimensions of the book characteristic comparison are discussed: (1) between books and book chapters, (2) between *edited books* and *authored books*, and (3) between aggregated and non-aggregated books. In the first comparison, books in all the four fields have higher citation equality than book chapters in terms of Gini coefficient, Leimkuhler curve and concentration ratio based on percentages of top cited publications, but they have more concentrated Herfindahl–Hirschman Indices and concentration ratios based on specific numbers of top cited publications. This pattern shows a higher evenness of books' citation distributions but also reveals the influence of a few top cited individual items among all the books. Book chapters are relatively more often uncited than books in all the fields, demonstrating the weakness as an evaluation unit in bibliometric studies. In addition, the citation distribution gaps of books between book chapters in terms of Leimkuhler curve related indices are larger in the SSH than the sciences, but the situation is reversed for the HHI related indices.

In the second comparison, *authored books* have an intermediate performance in terms of uncited rate, Gini coefficient and Leimkuhler curve between the whole *edited books* and individual *edited books*. Their patterns are very close to the whole *edited books* in Arts & Humanities in particular. The difference between the two investigated types of books across fields shows in HHI distributions. In the sciences *authored books* have higher HHI individual concentration than *edited books*, contrary to the SSH. In general, the distances of all the concentration indices between *authored books* and *edited books* are larger in the sciences than the SSH.

The third comparison contrasts single items of books with the aggregation of their items in two book groups. Among *edited books*, the differences between the single item of a book and all items of the book through all concentration indices are much more significant than *authored books* across all fields, but *authored books* have larger differences of average citation impact between individual books and the whole books than *edited books*, especially in the sciences. After combining these two aspects, the individual *authored books*, which have more smooth concentration distributions and higher citation impact, present themselves as an relatively important unit of bibliometric analysis for books as opposed to aggregated *authored books*. On the other hand, the aggregation of *edited books* matters for a more even citation distribution but lower citation impact, especially in the sciences. It may indicate the importance of an edited book itself as a citable item in the SSH. However, this also raises an issue of analyzing *edited books* in the sciences since the aggregation of this document type is almost pointless for evaluation practices but it boosts the citation evenness significantly to a level comparable to journal literature.

The above difference between two types of books could also be the result of different numbers of sub-items published in a book. For example, the samples of *edited books* in Biosciences in this study have 20.3 sub-items on average, while *authored books* in the same field have 12.6 sub-items on average. In Arts & Humanities, *edited books* have 17.4 sub-items on average, while *authored books* in the same field have 10.6 sub-items on average. The smaller amount of sub-items (books chapters) in a book leads to a smaller difference between the single item of a book and the whole book volume. Apart from this fact, the common condition of citing a book itself rather than a specific chapter needs to be taken into account, and recalls the problems of lacking a universal standard for authors to cite a book or its specific chapter as discussed in (Gorraiz et al., 2013; Chi et al., 2015).

5.1.2. Articles

Articles maintain relatively harmonic patterns across fields than books. *Journal articles* have more even citation distributions and higher citation impact than *book chapter articles*. Furthermore, the distance of citation equality between two article types is shorter in the sciences than the social sciences. Thus, *book chapter* is not a suitable unit in traditional bibliometric studies to compare with *journal articles*, especially in the sciences and the social sciences. In Arts & Humanities, *journal articles* are not cited as frequently as those in other fields, resulting in the most similar patterns of different concentration indicators between two groups. The less frequently cited *journal articles* and *book chapter articles* insinuates that books play a dominant role in Arts & Humanities and demonstrate arts and humanities as unique fields from others.

5.2. Field

The general field influence can be detected in the distances between the sciences and the SSH, from the results of similar patterns of different indicators in biosciences and chemistry, transformed patterns in the social sciences which are dissimilar but revealing the framework of those in the sciences, and unique ones in arts and humanities which are totally different from other fields. The heterogeneity among fields in the SSH is additionally evident. In general, the sciences have more similar accumulative citation distributions but more diffuse monopolistic concentration distributions among different document types than the SSH.

In particular, features among fields can be summarized as follows. First, the difference between the citation concentration distribution of *books chapters* and *journal articles* is smaller in Arts & Humanities than in other fields. This is mainly because *journal articles* were cited much less in this field. As mentioned in last section, books are more significant than other document types in arts and humanities. Second, among all the concentration indices applied in this study, the social sciences have the most similar citation concentrations between journal articles and books. Hence books and journal papers are more comparable in this field. Third, the difference between aggregated and non-aggregated *edited books* and the difference between *edited books* and *authored books* in terms of citation concentration and citation impact are larger in the sciences than the SSH. This implies that different types of books have more different concentration degrees and impact in the sciences than in SSH. The type of books need to be taken into account in the comparative studies of monographs and periodical publications in the sciences. Fourth, the aggregated *edited books* have more (relatively) similar cumulative citation distributions to *journal articles* in the biosciences and chemistry. The role of aggregated book in the sciences requires more discussion as mentioned in Section 5.1.1. In addition, in Biosciences the individual *edited books* have even lower Gini equality than *book chapters* which is the most unevenly distributed document type in other fields. The result shows that the citations of individual *edited books* are extremely concentrated in the field. Note that this is different from the discussion before for the difference caused by aggregation in *edited books*. The interpretation of this result could not be correspondingly extended to that bioscientists prefer to cite a book chapter rather than an individual (edited) book, since we are not comparing edited books and their own chapters.

5.3. Concentration index

This is the first study to measure concentration degrees of book and journal literature by different concentration indicators. The results show some harmony among different indicators. In particular, there are two groups of indicators from the results of this study which can be detected according to their design principle and effect. In the first group, the concentration ratio based on the percentage of top cited publications and the Leimkuhler curve, which combines and illustrates the concepts of the Gini index and the uncited rate, measure the degree of concentration from the same perspective of an overall equality and thus have relatively similar analyzed results. In the second group, HHI and the concentration ratios of the absolute amounts of top cited publications which emphasize larger players from a competition perspective show different results from the first group. For example, applying the first group indicators, distances among all document types are smaller in the sciences than in the SSH, while distances among all document types applying the second group indicators are more diffuse in the sciences than in the SSH. In other words, the sciences have closer patterns among all document types in terms of the Leimkuhler curve related indicators, but the SSH have more centralized patterns in terms of HHI related indicators.

The results of two aspects of concentration ratios applied in this study show clearly the differences between those two groups. In Fig. 8, the field difference is largely revealed in the concentration ratios of the amounts of top cited publications rather than in the concentration ratio based on the percentage of top cited publications. We should keep in mind that the property of sensitive to a few dominating items would be influenced by different sample sizes. The results clearly show that books in the sciences have a higher monopolistic concentration than in the SSH due to their small sample sets. Controlling for corresponding sample sets when applying the second group indicators is suggested here for further studies.

5.4. Citation window

A longer citation period does not affect citation concentration significantly in most fields. This result confirms the time independence of the citation distribution shown in previous studies (Glänzel, 2007; Larivière et al., 2009; Yang et al., 2010). In this study, the longer citation window improves the stability of citation concentration of *book chapters* the most, but not that of *journal articles* and *edited books*. The softer a field is, the stronger is the distance between *book chapters* with two citation periods in the field. For *authored books* the influence of citation period varies in different fields. In the sciences, *authored books* with longer citation window unsurprisingly have a more equal citation distribution as shown in the case of *book chapters*. However, in the SSH *authored books* with shorter citation window have smoother citation distribution even though one may expect a reverse circumstances.

6. Conclusions

This study investigated the citation concentration characteristics affected by different aspects such as document type, field, concentration index and citation window, and found that document type and scientific field have mutual influence on the citation concentration patterns based on two classified groups of indicators whereas a citation window longer than three years does not have such a strong effect. Following the main purpose of this study, i.e. to determine the best approach for comparing data from monographs and periodical publications, the results indicated complex suggestions from different dimensions.

First, *book chapter* is not a suitable unit in traditional bibliometric studies to compare with *journal articles*. *Journal articles* have more even citation distributions and higher citation impact than *book chapter articles*. In addition, the distance in citation equality between two document types is shorter in the sciences than in the social sciences. The results of this study indicate that citation analyses based on indicators designed for journal papers are not recommended to be applied for *book chapters*, especially in the SSH.

Second, *authored books* and *edited books* play relatively similar roles in terms of citation concentration in the SSH than in the sciences. By taking a further step inspecting the aggregation issue, the difference between aggregated volumes and individual articles in *edited books* is much larger than that in the *authored books*. The aggregation of *edited books* matters for a higher citation equality but lower citation impact. Its influence is larger in the sciences than in the SSH. This result may be due to the larger volumes of *edited books* in the science and imply that the edited book itself in the SSH is a more commonly cited item than a specific book chapter while combining the first conclusion. On the other hand, the aggregation of *authored books* does not differ so much and is not essential for consideration.

Third, every field demonstrates its distinct characteristics. The most heterogeneous field, the humanities, has a distinct pattern of citation concentration distributions among all document types. The findings of this study suggest that in this field *book chapters* and *journal articles* are not as suitable as books for the use in bibliometric studies. In the social sciences, both two types of books and journal papers are more comparable to each other due to the most similar citation concentrations between journal articles and books among all the fields. However, the high uncited rate of these document types is a factor impeding studies applying typical citation indicators in the social sciences.

The case is different in the sciences. The types of books need to be taken into account in the comparative studies of monographs and periodical publications in the sciences, because different types of books have more different concentration degrees and impact in the sciences than in SSH. In the sciences, individual *journal articles* have the least concentrated citation distribution and aggregated *edited books* are the medium that is most similar with *journal articles* in this regard. Even though an aggregation scheme is not useful for evaluation based on books, it is noteworthy that the effect of aggregation is stronger for *edited books* in the sciences than for those in the SSH.

Fourth, there are two groups of concentration indicators from a perspective of an overall equality and another competition perspective sensitive to larger players detected in this study according to their performance. The first group of Leimkuhler curve related indicators shows more similar accumulative citation distributions among different document types in the sciences than the SSH, while the second group of HHI related indicators has more diffuse monopolistic concentration distributions in the sciences.

Fifth, applying a citation window longer than three years does not affect the citation concentration of *journal articles* and *edited books*. It would only improve the stability of citation concentration for *book chapters*, to a larger degree in the Arts & Humanities. Precisely, the softer a field is, the stronger a distance between *book chapters* with two citation periods in the field would be. Since *book chapters* are not an attractive unit for bibliometric analyses of book publications according to the above conclusions, citation window is not an essential factor to be taken into account in the comparative studies of journal and book literature.

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