The Field-Specific Reference Patterns of Periodical and Nonserial Publications

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This study is concerned with differences in referencing patterns between book literature and periodical publications. Four indicators, the mean reference rate per page, the percentage of references to Web of Science journal literature, the mean reference age, and Price Index, were applied to analyze the reference patterns of three publication types: books, book chapter articles and journal articles. References of publications indexed in Web of Science Core Collection were analyzed for two periods (2005-2009, 2010-2013) and across 15 disciplines. Journal article authors cite more recent references and more references from serial publications than monograph authors. The difference between the sciences and the SSH is as obvious as the difference between periodical and non-serial publications. However, the reference patterns of social sciences are much more similar to science fields than humanities, especially for monographs. The subject characteristics of reference pattern are strongly affected by publication types. Furthermore, journal publications have stronger associations between ageing indicators and the share of WoS journal references than monographs.

Introduction

After the Book Citation Index (BKCI), a new collection in the Web of Science Core Collection (WoS), was released in 2011, the capability to retrieve monographic literature in abstract and citation databases was broadened. With the new data source, a deeper understanding of the peculiarities of publication, reception and use of book literature is necessary before bibliometric indicators can be developed and applied in an evaluative context. Following up the results of a previous study (Chi, 2016), which was devoted to the analysis of the distinct citation patterns of books alongside those of journal literature indexed in the WoS, in the present study I will study cited references of the two publication types to complete the exploration of the new data source.

Some studies compared cited reference analysis with the times cited approach, especially focused on the impact of cited and citing works and the normalization of citation scores across different fields (see Bornmann & Marx, 2013; Liang & Rousseau, 2010; Nicolaisen & Frandsen, 2008); some others made efforts on revealing the characteristics of references and exploring the information contained in references as much as possible. For example, Allen, Qin, and Lancaster (1994) reported the evolution of reference style from the 17th century to the 20th with an increase in references to journals and international works, as well as a gradual decline in the age of references in the mid-19th century. Glänzel and Schöpfli (1999) found that the percentage of references to serials is a sensitive measure of typical differences in the communication behavior between the sciences and the social sciences. This result supports the statement “science distinguishes itself from other fields of study by the way scientists refer to their literature” made by Wouters and Leydesdorff (1994, p. 194) based on the Price’s theory of knowledge growth (de Solla Price, 1965, 1970).

An increasing tendency in the number of references and a rising average age of references over time for several fields and topics has been found in journal publications (Krampen, 2010; Larivière, Archambault, & Gingras, 2008; Marx & Bornmann, 2015; Peritz & Bar-Ilan, 2002; Ucar et al., 2014). Ageing is not only influenced by the “level of abstraction” but also by the document types (Glänzel & Schöpfli, 1999, p. 32). Different document types also have different citing life-cycles in each topic. In fields where non-serial literature plays an important role in scientific communication the bibliometric standard methods based on journal articles may need to be modified to provide valid results. This is the reason why in this study I investigate the reference patterns of book literature and journal articles in different fields and lay a special focus on the social sciences and humanities (SSH) because of their specific publication behavior in favour of monographic literature.

The main objective of this study is to find out the subject characteristics of different publication types and whether book literature has different reference patterns

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than periodical publications. This study is the first research analyzing references of books on a large scale. The results of this study are expected to contribute to (1) a better understanding of the role of cited-reference based indicators in SSH, (2) the different characteristics of cited references of the two main publication types, and (3) a better understanding of the correlation among reference-based indicators measuring two different phenomenon.

Data and Methods

Data Sources

The complete 2005-2013 contents of the WoS, including the three journal databases SCIE (Science Citation Index Expanded), SSCI (Social Sciences Citation Index) and A&HCI (Arts and Humanities Citation Index), as well as the BKCI (Book Citation Index) have been processed as source documents in the 2016 volume of WoS custom data licensed by ECOOM – KU Leuven. Overlap among proceedings, books and journals was excluded to obtain duplicate-free datasets. To inspect the development of the observed groups over time, two periods (2005-2009, 2010-2013) were specified.

Publication Types

Three publication types were selected for further analyses: books, book chapters and journal articles. Two types of books, authored book and edited book, were considered. For authored books, I aggregated a book main item and all of its book chapters as a unit because the reference data of a book are provided either in the end of a book or each chapter. The share of 2005-2013 WoS publications without references in this study is around 22% for authored books, and 79% for book chapters in authored books¹. After aggregation, the share of authored books without references is reduced to 1.2%. Due to the absence of reference data of main items of edited books in the database, edited books are not aggregated and only their book chapters were analyzed in this study. The document type “Article” for edited book chapters and journal articles was used because of its central importance. Table 1 shows the details of each publication type.

Books. The bibliographic records and references of the publications with the document type “Book” in BKCI from 2005 to 2013 were retrieved. To avoid the influence of periodical books (e.g., annual review serials), I excluded those items having the joint publication type “Journal,” which are indexed in both SCIE/SSCI/AHCI and BKCI. Among all the books, records with editor but no author data were coded as *edited books*, whereas records with only author data were coded authored books. Two thousand nine hundred seventy-

¹ The higher percentages of no reference data for authored book chapters may imply that the reference lists in authored books are mainly provided (or indexed) for the whole books instead of individual chapters.

TABLE 1. Data definition of three publication types.

Counts	Book publications				Journal publications		
	Authored book (aggregated)		Book chapter in edited book		Journal article		
	Books	References	Chapters	References	Articles	References	References
Document type	25,475	6,136,618	252,532	2,473,680	9,360,403	306,474,071	306,474,071
Publication type	(Book $\wedge$ any type) $\vee$ (Book Chapter $\wedge$ any type)		Book Chapter $\wedge$ Article		Article		
Edition ^a	(Books in series/Books)\Journal (BSCI $\vee$ BHCI) \ (SCIE $\vee$ SSCI $\vee$ AHCI $\vee$ ISTP $\vee$ ISSHP)				Journal\Books in series (SCI $\vee$ SSCI $\vee$ AHCI) (BSCI $\vee$ BHCI $\vee$ ISTP $\vee$ ISSHP)		
Publication year			2005-2013				

Note. 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).

Source. Data sourced from Clarivate Analytics Web of Science Core Collection.

^aBSCI and BHCI are the science and the social sciences & humanities editions of BKCI.

TABLE 2. Sample sizes of three publication types in 16 research fields (2005-2013).

	Authored book		Edited book chapter		Journal article	
	Items	%	Items	%	Items	%
Agriculture & Environment (AGRC)	902	2.7	21,197	5.4	694,162	5.7
Arts & Humanities (ARTH)	10,560	32.2	53,069	13.6	323,644	2.7
Biology (BIOL)	452	1.4	18,276	4.7	908,695	7.5
Biomedical Research (BIOM)	242	0.7	13,064	3.4	600,359	4.9
Biosciences (BIOS)	232	0.7	20,187	5.2	821,398	6.7
Chemistry (CHEM)	716	2.2	17,454	4.5	1,814,214	14.9
Clinical and Experimental Medicine I (CLIN I)	159	0.5	19,360	5.0	929,482	7.6
Clinical and Experimental Medicine II (CLIN II)	848	2.6	35,982	9.2	1,516,755	12.4
Engineering (ENGR)	2,269	6.9	29,183	7.5	1,020,889	8.4
Geosciences & Space Sciences (GEOS)	745	2.3	11,411	2.9	520,181	4.3
Mathematics (MATH)	1,551	4.7	9,281	2.4	436,339	3.6
Multidisciplinary Sciences (MULT)	24	0.1	1,213	0.3	174,539	1.4
Neuroscience & Behavior (NEUR)	841	2.6	17,855	4.6	495,781	4.1
Physics (PHYS)	790	2.4	7,833	2.0	1,265,829	10.4
Social Sciences I (SOC I)	5,220	15.9	52,333	13.4	352,971	2.9
Social Sciences II (SOC II)	7,253	22.1	62,114	15.9	315,102	2.6
All ^a	25,475	-	286,146	-	9,360,403	-

Source. Data sourced from Clarivate Analytics Web of Science Core Collection.

^aThe total number of all publications is not equal to the sum of the publications in all the fields because of the multi-category classification of each publication source.

one books without editor or author data, and 669 books with both editor and author data were excluded in this study. An additional criterion for *edited books* applied here is that an edited book should have more than one item (i.e., at least one book chapter apart from the book item). Note that only aggregated authored books, which are the joint units of authored book main items and their chapter items in all document types, were analyzed in this study. Aggregated edited books are not used in this study because they are composed of chapters of generally independent character, which can be meaningfully analyzed on their own, whereas combining the chapters into a unit of analysis would entail the loss of information on the constituent, but largely independent parts.

Book chapter articles. All book chapter items in edited books published from 2005 to 2013, which are designated as “Article” and “Book Chapter” document types in BKCI, were analyzed for this category.

Journal articles. SCIE/SSCI/AHCI papers which are assigned the document type “Article” and the publication type “Journal” in WoS, published from 2005 to 2013, were treated as journal articles in this study.

Field Classification

All the samples were classified into 16 research fields and 74 subfields based on their WoS subject categories according to the modified Leuven-Budapest classification scheme (Glänzel, Thijs, & Chi, 2016), except for the excluded publications in five inter-disciplinary categories². The sample sizes in the 16 major fields are listed in Table 2.

Table 2 shows that WoS indexes books mainly in SSH, whereas the largest journal coverage can be found in chemistry, physics, and clinical medicine. The category Multidisciplinary Sciences is not reported in this study because of its insufficient size in book literature.

Indicators

In previous studies of referencing characteristics, the most commonly used indicators including the percentage of references to serials, the mean references age, and the mean reference rate have been applied in different disciplines and periods (Peritz & Bar-Ilan, 2002; Schöpfli & Glänzel, 2001; Wouters & Leydesdorff, 1994). The most commonly used bibliometric measure of reference ageing is the Price Index (Glänzel & Schöpfli, 1999; Schubert & Maczelka, 1993), which correlates with the mean age of references for literature with fast ageing. In this study, four indicators, the mean reference rate per page, the percentage of references to WoS journal literature, the mean reference age, and Price Index, were used to analyze the general reference features of the publication groups across fields.

Mean reference rate (per page). Studies focusing on journal literature show that the absolute numbers of references per paper differ among disciplines and periods, but there is a general increase in the average number of references in all fields. Ucar et al. (2014) presented a significant increase in the number of references per paper in engineering journals, the average rises from 8 in 1972 to 25 in

² Audiology & Speech-Language Pathology, Cell & Tissue Engineering, Ergonomics, Logic, Nanoscience & Nanotechnology

FIG. 1. Reference and citation distributions of three publication types (2005). Red dashed lines indicate mean values of reference numbers per item; blue dashed lines indicate mean values of citation numbers per item. Only the 2005 contents of the database were analyzed to assure a long-term citation window. Data sourced from Clarivate Analytics Web of Science Core Collection. [Color figure can be viewed at wileyonlinelibrary.com]

2013. Peritz and Bar-Ilan (2002) reported that the mean number of references for articles in the journal *Scientometrics* increased from 15.1 in 1990 to 19.8 in 2000. Krampen (2010) demonstrated a significant increase in the number of references of psychology papers in a 20-year period sampled in three years (1985, 1995, and 2005). Marx and Bornmann (2015) examined WoS papers in six major subject areas and found that the references on average of a paper in the social sciences increased from 23.11 in the year 1990 to 42.05 in the year 2010, whereas the average reference rate in the natural sciences increased from 21.43 in the year 1990 to 42.05 in the year 2010.

Because of the different lengths of volume works and individual items, the average numbers of references per item in different publication types are not comparable (see Figure 1). Thus, the definition of this indicator in this study is the ratio of the total number of references of publications

in each field or period to the total number of pages of those publications. Publications without reference data were included and treated as 0 references in the calculation. Note that the general share of publications without references in this study is 1.2% for (aggregated) authored books, 12% for book chapters in edited books and 1.7% for journal articles. The reference data of two authored books and three book chapters in edited books which show page counts as 0 were excluded in the study.

Percentage of references to WoS journals. The percentage of references to serials was used to measure the scholars' journal use, which is one characteristic in which subjects differ widely. For instance, literary researchers cite more books (75% of all references) than do scholars in other disciplines (Heinzkill, 1980). Glänzel and Schöpfli (1999) pointed out that about 80% of all science journals cite more than 70% of all references to serials, whereas all social science journals refer to at less than 70% references in serials. The percentage of references to WoS journals is somewhat different from the percentage of references to serials, focusing on a specific set of selected literature. It is also an indicator of the coverage of WoS indexed periodical literature in a given field, and shows a tendency of journal oriented publication strategy. van Leeuwen (2006) found that the faculties having more WoS source publications³ have larger shares of references to the indexed journal literature itself.

In this study this indicator is defined as the ratio of the number of references which are WoS indexed journals to the total number of references in a given field and/or year. The WoS accession number (UT code) was used for the matching of references and WoS indexed papers in the WoS custom database. Note that nonserials publications indexed in WoS are not included in the calculation as WoS references.

Mean reference age. This indicator is defined as the average difference of publication years of publications and their references in each field/period. Although publications usually cite works published in previous years, one year negative difference between a publication and its afterward reference is accepted in this study (i.e., the year difference between a publication and its corresponding reference should be bigger than or equal to -1). Shorter differences are treated as one year for the reference age calculation. References published before 1200 and after 2014 were excluded for this indicator because of the high data inaccuracy in this range (e.g., only 16% of publication year data of references which are indexed as published between 1000 and 1200 were found to be correct in a manual check

³ According to Butler and Visser (2006, p. 330), source publications are "articles appearing in journals indexed by the Institute for Scientific Information (ISI) in one of its three main indexes – Science Citation Index (SCI), Social Sciences Citation Index (SSCI), and Arts and Humanities Citation Index (A&HCI)."

FIG. 2. Dot plot of reference counts per page of three publication types in 15 research fields. AB = Authored Book; EBC = Edited Book Chapter; JA = Journal Article. Fields are ordered by the mean reference rate of journal articles 2005-2009. Data sourced from Clarivate Analytics Web of Science Core Collection.

of 25 random items, especially for the frequent cases of 19xx being indexed as 10xx). Only references with valid reference year, namely having four digits, were accepted.

The age of references has been studied for detecting the long-term trend of literature and used as a tool to establish the boundaries of fields. Larivière et al. (2008) found that the average age of references has risen continuously since the mid-1960s in an observation period of over 100 years, unveiling a trend that the more recent publications cite relatively older literature. Glänzel and Schöpfli (1994) focused on differences in the ageing of journal literature in science and the social sciences. Within the sciences, theoretical papers (e.g., in mathematics) are significantly “slower” than technology oriented or experimental research papers (e.g., in life sciences or engineering). In the social sciences, political science and business journals citing more recent references than the history, archaeology, and social sciences.

Price index. The Price index is an identifier for hardness of sciences⁴ (de Solla Price, 1970; Schöpfli & Glänzel, 2001; Schubert & Maczelka, 1993): the harder a science is, the higher its Price Index. According to Moed (1989, p. 474), the Price index is “the percentage of references in the scientific literature to 0 to 4 years old other publications.” The references published before 1200 and after 2014 were excluded in the calculation.

Larivière et al. (2008) found that Price Index values are decreasing since the mid-1950s and concluded that it is decreasing with the mean reference age. The Price Index is a decreasing function of the average and median reference age (Egghe, 1997; Glänzel & Schöpfli, 1995). Following the mentioned correlation between the mean age of references and the Price Index for literature with fast ageing, the correlation between these two indicators will be

⁴The “hardness” of sciences, revealing impersonality (Norman, 1967), is an indicator detecting different levels of publication patterns between the sciences and social sciences.

FIG. 3. Dot plot of shares of references to WoS journals of three publication types in 15 research fields. AB = Authored Book; EBC = Edited Book Chapter; JA = Journal Article. Fields are ordered by the values for journal articles 2005-2009. Detailed numbers are listed in Appendix B. Data sourced from Clarivate Analytics Web of Science Core Collection.

additionally tested by a linear regression analysis for each publication type in this study.

Results

Mean Reference Rate (per Page)

Authored books have much higher average numbers of references per item than other publication types, as shown in Figure 1. However, their average numbers of references per page are lower than journal articles’ and edited book chapters’. Figure 2 illustrates the data of fifteen fields generated from the three publication types in two periods (detailed numbers are shown in Appendix A), and shows that edited book chapters and journal articles in the life sciences have much higher average numbers of references per page than those in other fields, especially mathematics and humanities where the numbers in all the publication types are relatively low. In terms of the indicator’s changing patterns over time, Figure 2 exhibits an increasing trend of average numbers of references in journal articles.

Percentage of References to WoS Journals

All the publication types have increasing shares of WoS serials references in most fields during the two observed periods as shown in Figure 3. The largest (proportional) increase appears in Arts & Humanities. In agriculture and biomedicine related fields the increase for authored books are larger than for other publication types. In general, journal articles have much higher ratios than authored books.

Figure 3 shows that the fields Biosciences and Clinical and Experimental Medicine I have the most opposite features from SSH in this study in terms of the share of WoS journal references. The finding is in line with the coverage of journal literature in different fields in WoS, as well as the result that basic research in the life sciences and biomedical sciences exhibit the highest share of references indexed in the WoS in contrast to the humanities

FIG. 4. Dot plot of average reference age of three publication types in 15 research fields. AB = Authored Book; EBC = Edited Book Chapter; JA = Journal Article. Fields are ordered by the values for journal articles 2005-2009 with a descent order. Detailed numbers are listed in Appendix C. Data sourced from Clarivate Analytics Web of Science Core Collection.

(van Leeuwen, 2013). In these life sciences fields the shares of references to WoS journals in edited book chapters are similar to those in journal articles.

Arts & Humanities has the lowest rates for all publication types and the closest values among these types. The clear difference between the sciences and the SSH shown in Figure 3 is in line with the finding of van Leeuwen (2006). The figure of 20% for journal articles in Arts & Humanities here is in accordance with the findings in Heinzkill (1980).

Mean Reference Age

In each field, journal articles cite more recent references than books. Figure 4 shows that authored books are the publication type with the highest average reference age in all fields. They have increasing average reference ages over the two periods, whereas journal articles have no clear differences of reference age between the two periods. Edited book chapters have similar but slightly higher reference age than journal articles. Only in Arts & Humanities journal articles have higher reference age than edited book chapters.

Figure 4 also shows the distinct reference age patterns across fields. The characteristic of citing more historical references in Arts & Humanities with the highest reference ages is apparent. The social sciences, mathematics and geosciences have intermediate average reference ages. In contrast, engineering and the life sciences related fields have the lowest reference age. The results are in line with the literature obsolescence discovered by Glänzel and Schöpfli (1999): the obsolescence in the life sciences is relatively fast, contrasting to mathematical and social science literature.

Price Index

Authored books have Price Index values of between 0.1 and 0.2, and edited book chapters have higher values of between 0.2 and 0.3. Journal articles have the highest level of Price Index ranging from 0.25 to 0.4. Figure 5 shows

that most publication types, especially edited book chapters and journal articles, have decreasing Price Index values in most fields, similar to the finding of Larivière et al. (2008) based on journal literature. This result reveals a trend that researchers prefer to cite more frequently a smaller proportion of recent references, reflecting the pattern of citing earlier references as shown in the last section.

Field differences of this indicator can be identified in Figure 5. Arts & Humanities has the lowest Price Index among all the publication types. Note that the pattern in the social sciences clearly differs from the humanities. The Price Index values in the social sciences are more like those of neurosciences. The patterns of journal articles across fields shown in this study are generally in line with those already reported by de Solla Price (1970): biochemistry and physics having the highest values, followed by the social sciences, and the humanities at the low end of the range. However, the authored books have different Price pattern across fields from journal articles: clinical medicine and engineering have the highest values whereas humanities and natural sciences such as mathematics, chemistry and physics have the lowest values.

Correlation Among Reference Indicators

To test the correlation between the mean age of references and the Price Index in this study as studied by Glänzel and Schöpfli (1995), I measured the Pearson's r between these two indicators for each publication type with random samples from 2005 to 2013 ($N = 10,000$). All the results of them range between -0.61 and -0.50 (see Figure 6). This figure confirms that publications with higher average reference ages would have lower Price Indices for both journal and book literature.

Furthermore, the average reference age has a significant negative correlation with the share of WoS serials references in all the three publication types (between -0.49 and -0.20). This finding shows that cited serials references contribute to shorter reference age in the three publication

FIG. 5. Dot plot of price index of three publication types in 15 research fields. AB = Authored Book; EBC = Edited Book Chapter; JA = Journal Article. Fields are ordered by the values for journal articles 2005-2009. Detailed numbers are listed in Appendix D. Data sourced from Clarivate Analytics Web of Science Core Collection.

FIG. 6. Pearson's correlation matrices of three publication types (2005-2013). Note: 10,000 random samples for each group were used. Data sourced from Clarivate Analytics Web of Science Core Collection. [Color figure can be viewed at wileyonlinelibrary.com]

FIG. 7. Multidimensional scaling plots of reference-based indicators for three publication types in two observation periods. [Color figure can be viewed at wileyonlinelibrary.com]

types, especially the type of journal article. Figure 6 also shows that Price Index and the share of WoS serials references correlate with each other at medium level. The more serials a publication cites, the higher its share of recent references. However, the values of these correlations of authored books are not as high as those of journal articles.

Discussion

Field Differences

For a closer look at the differences across fields, Multidimensional Scaling (MDS; Borg & Groenen, 1997) was used to visualize the similarities of individual cases representing the four cited-reference based indicators in 15 research fields. All data of the four indicators of the different publication types and periods presented in last section were used to create distance matrices. The matrices

are used as the basis of the MDS analysis to generate two-dimensional scatterplots for the visualization of the between-object distances among all the fields. Arts & Humanities is the most distinct among the 15 fields (see Figure 7). It has the lowest share of references to WoS journals, the highest reference age, and the lowest Price index. Its average reference counts per page in edited book chapters and journal articles are less than other fields, whereas the aggregated authored books in Arts & Humanities own more references per page than natural sciences.

The invisible boundary between the sciences and the SSH can be located by these referencing characteristics. In general, the publications in SSH use more historical references and less WoS journal articles. This pattern is stable over a long period (cf. Heinzkill, 1980). However, a clear difference between the social sciences and humanities is found in this study. Figure 7 shows that social sciences are closer to basic sciences than humanities in terms of their reference patterns. In the sciences, mathematics,

geosciences, and physics display reference ageing patterns most similar to the SSH, whereas biosciences, biomedical research and clinical medicines stand on the other side of the ageing spectrum. This is in line with the obsolescence differences between mathematical and social science literatures of prior studies (Glänzel & Schöpfli, 1999) and reflects the finding of Glänzel and Schöpfli (1994) that the ageing of theoretical papers in the sciences (e.g., in mathematics) are significantly “slower” than technology oriented or experimental research papers (e.g., in life sciences or engineering).

Publication Type Differences

Aggregated authored books show very different reference patterns from journal articles in this study, citing more historical references than the other two publication types. In terms of the field difference of four reference indicators, Figure 7 shows that the social sciences are closer to the sciences in aggregated authored books than in journal articles. In other words, the differences between the sciences and the SSH according to the reference-based indicators are more apparent in journal articles than in monographs.

In contrast with aggregated authored books, journal articles own more recent references and more references from serial publications. Edited book chapters are more like journal literature compared to the whole book volumes. These two individual work types have increasing shares of references to WoS journals and decreasing Price Index in most fields during the two observed periods. The trend is generally in accordance with previous studies based only on journal literature (see Larivière et al., 2008; van Leeuwen, 2013).

However, in terms of the increasing average numbers of references per page over the two periods, the three publication types generally present the same trend which is in line with the observations of other studies of journal literature (e.g., Krampen, 2010; Marx & Bornmann, 2015; Peritz & Bar-Ilan, 2002; Ucar et al., 2014).

Field Differences Versus Publication Type Differences

In general, in the sciences, most notably, in physics and chemistry, one can observe a larger range of ageing indicator values among the three publication types than in other research areas. One explanation for the reason why the largest ageing differences among publication types occurred in natural sciences is the high share of WoS coverage and journal publications in the fields. According to the report based on a complete publication output data set in the higher education sector of Norway (Sivertsen & Larsen, 2012), 80% of Norwegian output in the natural sciences are indexed in the WoS; 89% of Norwegian output in the natural sciences are journal articles, whereas 11% of them are book chapters and 0.4% are books. The high

percentage of journal articles (especially in WoS) and low percentage of book publications in the natural sciences are the most striking in all fields in the Norwegian study. The largest gap between the publication amounts of different publication types may affect the results of the reference-based indicators in this study with a biggest publication type difference across fields. However, the significance of the concordance between these two findings could not be proven.

By contrast, the larger range of the measure of scholars' journal use (percentage of references to WoS journals) among the three publication types is shown in the social sciences. According to van Leeuwen (2006), the faculties having more WoS publications cite larger shares of references to the indexed journal literature itself. The large variance of referencing behavior in the social sciences is probably related to the distinct publishing behavior of social scientists. For example, the share of journal articles in the social sciences has increased more than 100% in the period 2000–2009 in a Flemish study while the share of books keeps a relatively stable growth of 35% in the same fields (Engels, Ossenblok, & Spruyt, 2012; Figure 6). Following the trend of journal-oriented publication pattern in the social sciences (see also Chi, 2015), a changing communication behavior of social scientists in favour of citing more journal articles in their journal publications can be found in the largest increase of the share of WoS references over time (see Figure 3). On the other hand, Figure 3 also shows that when publishing books, social scientists retain the similar behavior as humanists to cite mainly nonserial references, which reflects the stable evolution of books in the Flemish study.

Correlation Among Reference Indicators

All the three publication types have significant medium but negative correlations between the mean age of references and the Price Index (Glänzel & Schöpfli, 1995). The authors citing more historical references do have a lower chance to have a high proportion of recent references. Both ageing indicators correlate with the share of WoS serials references. Price Index and the share of WoS serials references correlate with each other at a medium level; the average reference age also has a significant negative correlation with the share of references to WoS journals in all the three publication types. It implies that cited serials references are more recent than cited nonserials references. This medium level correlation is like the finding that the percentage of references in serials has only a small effect on the reference age for journal articles, reported by Glänzel and Schöpfli (1999). However, book publications have weaker associations between the two ageing indicators and the share of WOS journal references than journal papers. This could be a result of book authors'

preference of citing historical nonserial references, with low shares of WoS journal references especially in SSH.

Conclusions

Aggregated authored books (monographs) have significantly different reference patterns from journal articles. Journal article authors cite more recent references and more references from serial publications; journal articles have stronger correlations between ageing indicators and the share of WoS journal references than monographs. Citing more WoS journal papers does not strongly shorten the reference age of monographs. Thus, the field-specific differences among reference-based indicators are more apparent in journal articles than in monographic literature. This difference between publication types suggests a cautious use of bibliometric indicators, that were originally designed for journal articles, in the context of book publications. Furthermore, the difference between the sciences and the SSH is as obvious as the difference between two main publication types. Publications in the sciences use more recent references and more references from WoS journals. The reference-based indicators in the SSH are as useful as those in the sciences to distinguish field characteristics, especially for revealing the gap between the reference patterns in the sciences and the SSH.

Another evident finding is the gap within SSH. The reference patterns of the social sciences are much more similar to science fields than to humanities (see Figure 7). As discussed in the previous study (Chi, 2016), humanities has the most distinct citation distributions among all the fields. Its exceptional reference patterns shown in the present study may reveal the cause of the citation patterns reported in Chi (2016). Furthermore, the journal papers in the social sciences are more isolated from science fields in Figure 7 than the monographs in the social sciences. These social sciences monographs have similar reference patterns to the monographs in (theoretical oriented) basic sciences than those in (experimental oriented) life sciences.

Appendix A. Reference counts per page of three publication types in 15 research fields

	Authored book		Edited book chapter		Journal article	
	05-09	10-13	05-09	10-13	05-09	10-13
Time period	05-09	10-13	05-09	10-13	05-09	10-13
AGRC	1.20	1.27	2.59	2.87	3.40	3.90
ARTH	1.17	1.21	1.44	1.44	1.60	2.05
BIOL	1.85	1.87	4.00	3.93	3.92	4.27
BIOM	1.82	1.60	3.93	3.99	4.01	4.32
BIOS	1.72	1.59	3.93	3.55	4.18	4.46
CHEM	1.31	1.29	2.70	2.71	3.81	4.36
CLIN I	2.01	2.12	4.83	4.53	4.35	4.32
CLIN II	1.51	1.63	3.68	3.67	3.93	4.11
ENGR	0.71	0.74	1.59	1.68	2.09	2.56

GEOS	1.20	1.12	2.80	2.70	3.12	3.65
MATH	0.66	0.69	1.46	1.57	1.32	1.53
NEUR	1.52	1.47	3.45	3.43	3.89	4.37
PHYS	0.90	0.91	1.99	2.12	3.04	3.42
SOC I	1.24	1.27	1.75	1.84	2.47	2.86
SOC II	1.19	1.15	1.48	1.66	1.94	2.48
All	1.15	1.17	2.24	2.45	3.21	3.55

Source. Data sourced from Clarivate Analytics Web of Science Core Collection.

Appendix B. Shares of references to WoS journals of three publication types in 15 research fields

	Authored book		Edited book chapter		Journal article	
	05-09	10-13	05-09	10-13	05-09	10-13
Time period	05-09	10-13	05-09	10-13	05-09	10-13
AGRC	0.34	0.39	0.61	0.63	0.67	0.70
ARTH	0.11	0.11	0.19	0.23	0.19	0.24
BIOL	0.65	0.64	0.79	0.80	0.79	0.80
BIOM	0.72	0.77	0.85	0.86	0.86	0.86
BIOS	0.78	0.80	0.89	0.89	0.90	0.89
CHEM	0.69	0.71	0.79	0.81	0.82	0.84
CLIN I	0.83	0.81	0.88	0.89	0.88	0.87
CLIN II	0.53	0.57	0.79	0.80	0.79	0.79
ENGR	0.41	0.42	0.48	0.50	0.56	0.60
GEOS	0.53	0.50	0.60	0.59	0.71	0.73
MATH	0.49	0.52	0.51	0.52	0.62	0.65
NEUR	0.53	0.52	0.71	0.72	0.80	0.81
PHYS	0.69	0.66	0.75	0.77	0.82	0.83
SOC I	0.16	0.17	0.26	0.29	0.44	0.47
SOC II	0.17	0.18	0.28	0.30	0.41	0.45
All	0.26	0.30	0.62	0.66	0.76	0.77

Source. Data sourced from Clarivate Analytics Web of Science Core Collection.

Appendix C. Average reference age in years of three publication types in 15 research fields

	Authored book		Edited book chapter		Journal article	
	05-09	10-13	05-09	10-13	05-09	10-13
Time period	05-09	10-13	05-09	10-13	05-09	10-13
AGRC	20.3	19.4	13.2	13.9	12.4	12.2
ARTH	40.1	42.5	29.8	32.2	31.0	33.5
BIOL	22.1	24.8	14.2	14.4	13.1	13.8
BIOM	19.2	16.2	11.8	11.4	10.5	11.0
BIOS	18.3	17.2	11.5	12.2	10.0	10.8
CHEM	19.9	19.4	12.8	12.7	11.6	11.3
CLIN I	19.0	15.7	12.0	11.7	9.2	9.7
CLIN II	16.1	17.2	12.6	13.2	10.7	11.0
ENGR	17.0	17.0	11.7	12.0	11.3	11.2
GEOS	21.8	24.8	17.3	17.6	13.5	14.1
MATH	22.2	24.6	16.8	16.4	15.5	15.8
NEUR	19.8	19.8	14.3	14.1	11.6	12.1
PHYS	21.6	21.6	13.5	14.4	12.0	12.3
SOC I	23.1	26.0	15.6	15.9	13.3	13.8

SOC II	20.2	21.3	14.1	14.5	12.7	13.7
All	27.3	28.0	14.9	14.6	11.9	12.3

Source. Data sourced from Clarivate Analytics Web of Science Core Collection.

Appendix D. Price index of three publication types in 15 research fields

	Authored book		Edited book chapter		Journal article	
Time period	05-09	10-13	05-09	10-13	05-09	10-13
AGRC	0.20	0.21	0.26	0.24	0.28	0.29
ARTH	0.09	0.08	0.14	0.13	0.17	0.16
BIOL	0.15	0.15	0.23	0.23	0.29	0.28
BIOM	0.19	0.20	0.29	0.29	0.34	0.32
BIOS	0.20	0.25	0.31	0.26	0.37	0.33
CHEM	0.16	0.17	0.32	0.29	0.35	0.36
CLIN I	0.23	0.21	0.27	0.26	0.38	0.36
CLIN II	0.25	0.22	0.25	0.23	0.33	0.32
ENGR	0.21	0.20	0.30	0.29	0.33	0.33
GEOS	0.16	0.14	0.23	0.20	0.30	0.28
MATH	0.15	0.14	0.21	0.21	0.25	0.25
NEUR	0.17	0.17	0.22	0.21	0.29	0.28
PHYS	0.16	0.15	0.28	0.26	0.36	0.35
SOC I	0.18	0.16	0.24	0.23	0.28	0.26
SOC II	0.22	0.20	0.29	0.27	0.29	0.27
All	0.16	0.15	0.26	0.24	0.33	0.32

Source. Data sourced from Clarivate Analytics Web of Science Core Collection.

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