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JOURNAL-TO-JOURNAL CITATION DATA: ISSUES OF VALIDITY AND RELIABILITY

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Citation analysis is a useful method for studying a wide range of topics in bibliometrics and the sociology of science. However, many challenges have been made to the validity and reliability of the underlying assumptions, the data, and the methods used in citation studies. This article addresses these issues in three parts. First is a brief review of validity and reliability issues in citation research. Next we explore measurement error in a principal source of journal-to-journal citation data, the Institute for Scientific Information's *Journal Citation Reports.* Possible sources of measurement error include discrepancies between citing and cited data, changed or deleted journal titles, aberrant abbreviations, and listing algorithms. The last section is a detailed description of ways to overcome some of the measurement errors. The data and examples are drawn from a journal-to-journal citation study in the fields of Communication, Information Science, and Library Science.

Uses of citation data

By 1980, there were over 2000 published articles in the research area of bibliometrics (*Hjerppe,* 1980). A component of this field is citation analysis, first used in either 1848 or 1927, depending on the criteria (*Broadus,* 1987; *Garfield,* 1979). Citation analysis deals with the study of relationships among authors, articles, journals, concepts, etc. as measured by references in documents. Citation analysis is one research tool in studying the sociology and structure of science, including topics such as the existence and changes in disciplinary and subdisciplinary boundaries; growth or decline of paradigms; patterns of communication within and across research fields, institutions, and authors; status differences in methods, research topics, and researchers; identification of research topics; describing invisible colleges of

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researchers (*Beniger,* 1988; *Borgman & Schement,* 1988; *Burt,* 1978; *Chubin,* 1983; *Crane,* 1972; *Garvey,* 1979; *Hagstrom,* 1965; *Paisley,* 1984; *Smith,* 1981; *Ziman,* 1968).

An essential motivation behind citation analysis is that in order for scientific knowledge to be accepted and to accumulate, it must withstand public evaluation and replication. Publication in an academic journal is one criterion for the scientific quality of a paper as well as for the contribution of the researcher, and publication provides a major basis for replication and development of the knowledge by other researchers. Thus citations are a basic measure of the patterns of scientific development and activity (*Cole & Cole,* 1971).

Analyses of citation data may involve (1) citations to a given document, (2) co-citations of articles appearing in two or more reference lists, (3) co-citations of authors, (4) citations to journals to determine the quality, utility or "impact" of journals, and (5) citations among journals to identify forms of scientific social structure and the differential influence of different sources and disciplines of prior research. [See, for example, *Broadus,* 1987; *Buss & McDermott,* 1976; *Cawkell,* 1978; *Doreian,* 1985; *Edge,* 1979; *Garfield,* 1984; *Gordon,* 1982; *Hirst,* 1978; *Line,* 1985; *Mace & Warner,* 1973; *McAllister, Anderson & Narin,* 1980; *Midorikawa,* 1983; *Satariano,* 1978; *Singleton,* 1976; *Small,* 1981; *Smart,* 1983; *Smith,* 1981; *Smith & Caulley,* 1981; *White & Griffith,* 1982; *Wiberley,* 1982. For journal-to-journal citation analyses, see, for example, *Borgman & Schement,* 1988; *Brown & Gardner,* 1985; *Burt,* 1978; *Burt & Doreian,* 1982; *Carpenter & Narin,* 1973; *Cason & Lubotsky,* 1936; *Doreian,* 1985; *Doreian & Fararo,* 1985; *Narin, Carpenter & Berlt,* 1972; *Narin & Garside,* 1972; *Paisley,* 1984; *Reeves & Borgman,* 1983; *Rice, Borgman & Reeves,* 1988; *So,* 1988; *White & White,* 1977; *Zhignesse & Osgood,* 1967].

This article reviews issues of both validity and reliability of journal-to-journal citation data, but focuses on reliability problems, and how they may be reduced.

Validity and reliability issues

The assumptions behind using citation data as objective measures of quality, impact, scientific social structure, or communication channels among scientists – its validity – have received considerable analysis and criticism. The level of error in different sources and forms of citation data – its reliabliity – also has been analysed. [See *Cole & Cole* (1971) *Edge,* (1979), *Garfield* (1979), *Porter* (1977), *Rushton* (1984), *Smith* (1981) and *Thonre* (1977).]

Validity of citation data

Issues of validity primarily focus on whether citations are objective indicators of the flow of scientific and technical information, and thus of the social structure of science. The assumptions behind the use of citation data have been well identified and questioned. They include the following: a citation of a document implies the use of the document, a citation reflects the quality of the cited document or idea, citations are made to the best possible works, mutually-cited articles or authors are in fact related in content, and all citations have equal weight. However, there are many purposes for a citation, not just as an objective measure of the communication of prior published research. These include homage to pioneers; unreasonably citing oen's own work; credit for related work; identifying methods or equipment; pointers to related work; correcting one's or another's work; criticizing, disclaiming or disputing the priority of another's work; substantiating claims; documenting forthcoming work; authenticating data or facts; identifying original sources for an idea or concept; or following disciplinary norms for citing (*Smith,* 1981). Similarly, there are reasons for not citing otherwise relevant literature: it is not perceived as relevant, the author is not aware of the prior work, it is not obtainable, or the work does not meet disciplinary citing norms (such as conference proceedings) (*Smith,* 1981). *Edge* (1979) considers more fundamental aspects of the validity of citation data, questioning whether citation data can indeed be used as a indicator of conscious information-seeking, intentional use of valuable information, and successful influence processes among scientists.

There are other threats to the validity of citation data. One is that for a document's citations to other documents to be indexable, and for the document itself to be available for citation by other documents, it generally must be published. However, the boundary between a published paper and an unpublished paper may be quite unpredictable and unclear (*Crane,* 1974; *Cummings & Forst,* 1985; *Lindsey,* 1978; *Lock,* 1985; *Nord,* 1985; *Powell,* 1985). Criteria used to evaluate submitted papers often do not predict acceptance better than chance, even when previously published articles are resubmitted in disguised form, and papers may be resubmitted to different journals until they are accepted (*Bohannon,* 1986; *Scott,* 1974; *Peters & Ceci,* 1982; *Whitman & Eyre,* 1985; *Zuckerman & Merton,* 1971).

Reliability of journal citation data

Problems with the reliability of citation data also exist, including the fact that mutual influence and collaboration is often underestimated, similar citations may be referring to different content, only first-named authors are listed in citation indexes,

Table 1
Producers, number of journals reviewed, and vendors for selected online databases.
Source: *Williams* (1985)

Database name (Database producer)	Number of Journal titles reviewed	Online vendors
CA Search (Chemical Abstracts Services)	12 000	BRS Data-Star ESA-IRS Dialog SDC Questel CAS Online
PsycINFO (American Psychological Association)	1 200	BRD Data-Star Dialog DIMDI SDC
SocialSciSearch (Institute for Scientific Information)	1 400	BRS Dialog DIMDI
Management Contents (Management Contents)	700	BRS Data-Star Dialog SDC Source
ABI/INFORM (Data Courier)	550	BRS Data-Star Dialog ESA-IRS SDC ITT Dialcom

co-authors receive equal weight, authors' names may be similar, sources of citation data vary, widely accepted ideas may not be specifically cited, different journals and different disciplines may have different citation half-lives, citations in different disciplines may have unequal value, and basic errors occur such as incorrect citing (*Boyce & Banning,* 1979; *Goodrich & Roland,* 1977; *Thorne,* 1977; [all cited in *Smith,* 1981]).

Another aspect of citation data reliability is the assumption that once a journal is published, its citation data are as accessible as data from other journals. Abstracting and indexing (A&I) services are responsible for making these data available in comprehensive and accessible form, by selecting journals and indexing articles. (Table 1

lists selected online databases and their respective producers, as well as the number of journals reviewed by each of the database compilers, and the online vendors providing access to the databases to users throughout the world, as of 1985.) These services vary widely in their criteria for selecting journals for inclusion, in the choice of articles to be indexed from the selected journals, and in the depth and types of access provided, as the next section briefly describes.

Validity and reliability issues in journal selection

Producers of several Abstracting and Indexing (A&I) services were contacted in order to study their criteria for selection of a journal (*Hart,* 1987), including the Institute for Scientific Information's (ISI) *SocialSciSearch,* the American Psychological Association's *Psychological Abstracts,* Chemical Abstracts Services' *CA Search* and Management Contents' *Management Contents.* Journal publishers included Praeger, Elsevier, Wiley and *The New England Journal of Medicine.*

Acquisition of journals by abstracting and indexing services

A&I services become aware of journals that are not already incorporated in their databases through a variety of means such as publishers sending a sample copy of their journal or promotional material to the service, or editors writing the A&I service requesting review. The ISI staff, for example, processes roughly 4000 letters annually, many of which are written to attract the attention of the selection staff.

If a journal is accepted, it is routinely acquired in one of the following ways: (1) complimentary copies, (2) subscription, or (3) if the A&I service is part of a larger professional association which also publishes journals of its own, the service may exchange copies of its publications with those of other publishers. At Chemical Abstracts Services, roughly half of the journals indexed and abstracted are currently unsolicited; of those solicited, some are paid for through subscription fees, and some are obtained through exchange agreements. The American Psychological Association uses all three means of acquiring journals; the service currently pays full subscription rates for only 3% of its journals, and exchanges its own published journals for journals from other publishers. This is in sharp contrast to the arrangement at Management Contents which obtains virtually all of its journals through subscriptions. ISI pays no subscription fees for journals covered by its *SocialSciSearch.* Publishers seeking exposure through selective and reputable databases are more willing to provide unsolicited copies of their journals to the A&I services, whereas smaller services which compete with larger database compilers that already cover the journal must pay

subscription fees. How an A&I service acquires a journal – and thus the reasons why its citation data may or may not be accessible – thus appears to be somewhat of a function of a particular journal's need or desire to be incorporated into the service's database.

Also at issue is the identification by the editor, sponsoring association, or publisher, of potential markets for subscription and use. A narrow identification will lead the journal to investigate possible relationships with a small number of specifically-focussed A&I services. Once a journal is established and considered valuable, however, A&I services will independently index it, though their choices may not exactly coincide with the journal's assumed audience.

Dickman (1984) and *Dickman & Plateau* (1983) have identified five general considerations typically used to determine whether a journal will be reviewed: (1) availability: the journal must be available to the public: (2) accessibility: the article from the journal must be retrievable either through subscription, a library, or document delivery service; (3) citability: a complete citation for articles and journals must be available which may include identification codes such as the International Standard Serial Number (ISSN) or codes pertinent to a particular field of scholarly journals such as the International CODEN number; (4) journal content; and (5) editorial quality.

Criteria used for article selection

In addition to these different ways of acquiring journals, A&I services differ, to a great extent, on the basis of journal content and editorial quality. To be more specific, journal content is not the ultimate criterion that determines selection of articles which provide the basic citation data; rather, article content is. Each article of each journal issue may be reviewed individually to determine its relevance to the A&I service's scope and content. A&I services may eliminate certain texts automatically, such as book reviews, case studies, articles based on interviews, or letters to the editor.

Producers of *Psychological Abstracts* and *Chemical Abstracts* select articles on the basis of the article's relevance to their respective fields and attempt to provide as comprehensive a service as possible. ISI does not aim for completely comprehensive coverage, however: ISI selects articles both on the basis of their relevance to a variety of scientific fields, and to some extent on the basis of the influence and dominance of a set of core journals (*Garfield,* 1980: 447). When a journal is reviewed for the first time at ISI, however, other criteria come into play: the opinions of experts in the field which the journal covers, recommendations of subscribers (solicited and unsolicited), the track record of individuals on the editorial board, and unless the journal is of exceptional quality, the subscriber base of the journal (e. g., journals of very limited circulation are not included) (*Garfield,* 1985).

Management Contents includes articles pertaining to management, finance, accounting, marketing and advertising. Only articles in journals with large circulations are selected. Most of these are published in the U. S., some in Canada, and a few in Great Britain. Its principal competitor is ABI/Inform, a large vendor providing a number of databases on management-related topics. Thus it intends to reach a subset of the market by providing abstracting and indexing services covering the most popular journals in the field. Journals and articles selected for these databases are a function of marketing strategy.

One conclusion from this small study of A&I services is that selection is always based on content, but is also matched with some other criteria which reflect the particular purpose of the database producer. Thus, in using citation data for research, we must consider the sources of the data provided by the abstracting and indexing services, and the filtering process that has occurred through editorial policy.

Reliability issues in journal citation reports data

Primary sources for citation data used in bibliometric studies are the three citation indexes produced by the Institute for Scientific Information: *Science Citation Index, Social Sciences Citation Index,* and the *Arts and Humanities Citation Index.* They are far more useful for citation studies than are other A&I services for two main reasons: (1) in addition to the usual bibliographic data on published articles, these indexes provide the explicit links between citing and cited articles, and (2) they provide an annual report on the citation links among journals and include various summary data. The latter data appear in the *Journal Citation Reports (JCR)* volume of each index.

Journal-to-journal citation study

This discussion of reliability issues in journal-to-journal citation data is based on our experiences in compiling data from the *JCR* volume of the *Social Sciences Citation Index* (*SSCI*) for the years 1977 through 1985 for a study of the relationships among journals in the fields of communication and information and library science (*Reeves & Borgman,* 1983; *Rice, Borgman & Reeves*, 1988; and research in progress).

We manually extracted from the *SSCI JCR* all of the citing and cited data from all journals in *SSCI*'s 1985 list of "Fully Covered Source Journals Arranged Alphabetically Within Subject Categories" for the subject areas "Communication" and "Information Science and Library Science." *JCR* does not include the criteria for assigning a journal to a specific category, raising potential questions about the

validity of its listing. However, we chose *SSCI*'s *JCR* as a basis for our study for two reasons: (1) *SSCI* is so widely used that the list represents a legitimate "standard", and (2) data are available for the core journals on this list.

We began our data collection with the first year for which a *JCR* volume was compiled for *SSCI* (1977) and ended with the 1985 *JCR* volume, the most

Table 2
Journals listed in *SSCI*'s 1985 *JCR* "Fully Covered Source Journals", with improved totals. Source: *SSCI* (1985)

	Total
# of titles within category "Communication"	21
# of titles within category "Information Science and Library Science"	57
# of titles duplicated by "Communication" and "Information Science and Library Science" lists (*Telecommunications Policy*)	− 1
# of titles listed by *JCR* but not actually covered in the *JCR* listings *(Critical Studies in Mass Communications)*	− 1
Total # of unique "Communication" and "Information Science and Library Science" covered listed by *JCR*	76
# of title changes identified for these 76 journals	19
Total # journal titles used in 1977-1985 *JCR*	95

current issue available at the time the research was conducted. Table 2 shows the distribution of the journal titles for the two subject areas. The *SSCI* list changes slightly from year to year as journals are added, dropped, or change titles (as discussed below) . The purpose of our citation study was to identify changes in these two disciplines over time, so we analyzed the most consistent set of journals through the nine years (as discussed below).

SSCI editorial policy

In evaluating the reliability of the *SSCI JCR* data, we must consider the method by which it was compiled. The information here was drawn from the introductory material in the *SSCI JCR* volumes (*SSCI*, 1981, 1984, 1986).

We collected data from the two main parts of the *JCR*: the Citing Journal Listings, which are organized by the title of the journal making the citations, with lists ("subentries") of journals to which cites were made; and the Cited Journal Listings, which are organized by the title of the journal receiving the citations, with lists (subentries) of the journals that made the citations.

Both the Citing and Cited listings include data from all three of the *Science Citation Index, Social Sciences Citation Index,* and the *Arts and Humanities Citation Index.* Thus, citations made to or received from journals in related disciplines are included. According to the introductory material, the Citing Journal Listing includes entries for "most of the more than 1440 journals fully covered by the *SSCI* in 1984, provided that issues of the journal did appear during that year." (*SSCI,* 1984: 35A). Similarly, the Cited Journal Listing "includes entries for more than 1350 social sciences journals and other items, some of them obviously not covered by the *SSCI.*" (*SSCI,* 1984: 35A). Some journals are processed with incomplete data, if the full data for the year was not available by the processing date of early February of the following year (*SSCI,* 1981: 6A). Implications of this aspect are discussed further below.

The Citing listing also includes citations to journals and books not otherwise covered by ISI, although ISI does not indicate how these are chosen. Thus, the citing entry for a given "fully covered source journal" (FCSJ) will contain both FCSJs and non-covered journals, but the cited entry for a given FCSJ generally contains only citations received from other FCSJs. This policy statement suggests that that some cites from non-SSCI journals might be listed, but these were not of concern to our citation study.

Reliability issues

Our study required a closed set of citations made among all of the Communication and Information Science and Library Science journals during the nine years covered. That is, we were concerned only with citations made from one journal on our list to any other journal on our list. We ignored all citations made to, or received from, journals outside this set.

We began our study with the hope of building a complete citing/cited matrix for each of the nine years of journals. We quickly found that this was not possible and were left with incomplete data. Some of the gaps were due to our method of tracing one set of journals through nine years. Other gaps were due to the way in which the *JCR* are compiled. The rest of this section is devoted to a discussion of the factors identified.

Journals studied not covered every year.

In studying changes in relationships among journals over time, we could not avoid problems related to varying coverage of our journal list over the nine-year period studied. Given the *JCR* data available, we sought to compile citing data for every year in

which a FCSJ was covered and cited data for all years. Several factors prevented us form achieving this level of data collection:

a) The journal existed and was published in that year, but not yet covered by the SSCI. We could get cited data but not citing data. Because we were working with a closed set of journals, we could pick up cited data for journals that were not fully covered in a given year from the citing listing of other journals in our set, thus building a more comprehensive dataset. This approach made it possible to find entries for a given journal in the citing list of core journals that were covered that year, even if it were not covered in that year. For example, *Human Communication Research* was first listed in the 1983 volume, making citing data available only for 1983 through 1985. By searching the citing lists of our other journals in prior years, we could identify citations received by this journal in years prior to 1983.

Cited data collected this way are necessarily incomplete. We could not detect citations made by any journals not yet covered in a given year, and we could never get self-citing data for non-FCSJs. We felt that partial data were better than no data and that partial data at least provided a minimum approximation of the activity of a journal in a given year. The additional data collected through this and other techniques dramatically changed the size and character of our dataset, as will be seen later.

b) The journal had not yet begun publication in the year in question. Thus, no cites could have been made to that journal in that year.

c) The journal ceased publication prior to the year in question. If it was still a FCSJ, we could get cited data to prior years of the journal but no citing data existed.

Variant forms of titles

We encountered two different kinds of problems with the forms of journal titles, each of which could be partially alleviated through bibliographic investigation.

a) The journal was published under a different title in a given year.

We found a number of cases in which a journal existed as a FCSJ in another year, but under a different title, or that we could find cited data under a prior or subsequent title even if the journal was not a FCSJ at that time. By searching through standard bibliographic sources (CALLS, RLN, OCLC, Ulrich's International Preiodicals Directory, 1986) and local serials records, we were able to identify 19 additional titles that were either former titles of the journals on the 1985 *SSCI* list. (See Table 2.) We then searched for all titles on this larger set throughout the nine-year period.

The publishers are aware of this problem, but have explicitly chosen not to combine journal counts on the basis of "lineage" even when it is clearly definable. The exception is "where a title change has been so minor (usually among latter words)

that it neither affects the title's position in a catalog listing nor requires additional or different entries" (*SSCI*, 1984: 9A). The *JCR* provides no indication of the occurrence of name changes, leaving the researcher to pursue the possibility of title changes in any and all journals.

b) Journal titles were sometimes abbreviated in unique ways that inhibited accurate identification of the journal name. Each FCSJ has a standard abbreviation intended for use in all citing and cited entries. A list of the journal abbreviations used by *SSCI* in the citing/cited listings appears in the introductory pages of each *JCR* volume. However, aberrant abbreviations of journal titles are occasionally used. Aberrant abbreviation forms occur only as subentries in the citing listing, and not in the cited listing. We assume this distinction is related to *SSCI*'s methods for generating its index. The source of these aberrant abbreviations is not stated in the *JCR* material, but because they appear only in the citing subentries, we suspect that they are raw form of data that is sometimes found in journal article reference lists. Table 3 presents a small sample of the many aberrant abbreviations we identified in *SSCI*.

Table 3
Selected examples of standard and aberrant abbreviations in *JCR*

Standard	Aberrant
Commun Monogr	CM
J Broadcast	J Bdcstg
B Med Libr Assoc	Bull Med Libr Ass
Soc Sci Inform	Soc Sci Informati
Gov Publ Rev	Government Publicati
Int Classif	Int Classificat
Libr J	Library J Aug
Nauch-Tekhn Inform 2	NTI 2

In many cases, the link between an aberrant abbreviation and one of the core journals was obvious (e. g., *Library J* rather than *Libr J*). In other cases, the abbreviation is ambiguous with respect to our list (e.g., *Inform Processi* may represent *Information Processing*, a non-core journal, or *Information Processing & Management*, a core journal). When the link between the abbreviation and the journal title was not apparent, we examined the bibliographic references in the actual physical issues of the citing journal to ascertain the full name of the journal being cited.

Our efforts to search 76 journal titles in multiple bibliographic sources and to examine physical volumes of journals to verify aberrant abbreviations was extremely labor-intensive. We were able to perform these tasks only because we were working

at an institution with an exceptionally strong journal collection in the subject area under study, and were further assisted by online access to local serials records. Researchers with fewer institutional resources would have great difficulty identifying title changes and variant forms of title abbreviations.

Missing or unavailable data

Some data that should have appeared in the *JCR* volumes were not present, and some data that were available were suppressed in printing. Both of these problems raised reliability concerns.

a) The title was recognized by SSCI as being a "fully covered source journal" for that year, yet no entry appeared in one or both of the citing and cited data lists. In these cases we were forced to treat the journal as though it were not covered in that year. The missing data appear to be due to editorial policy regarding the publication cycle of a journal and the availability of the data for inclusion in the *JCR*, as noted above. This policy suggests that to be included at least one issue must be published in that year and that only data received by early February of the following year is included. The statements do not state precisely how much data must be available for a journal to be included in the *JCR*, however.

b) The data exist but have been suppressed. The *JCR* does not make an explicit entry for every cited journal title in the citing entry, nor does it make an explicit listing for every citing title in the cited entry. Rather, only the most frequently cited or citing journals are listed, with the cut-off point determined by a complex algorithm:

> It would have been uneconomical to give for every citing journal all the journals it cited, and for every cited journal all the journals that cited it . . . In the Citing Journal Listing, the following algorithm was adopted. The subentry lists of cited journals are limited to a maximum of 100 items, or to the number of items that account for 85% of the total citations. Where either condition would allow listing of items cited less than fifteen times in the year, the items are not printed as subentries but are incorporated in the ALL OTHER subentry, the last subentry under each main entry. Disregarding these conditions, at least six subentries must be printed, if the main entry journal can supply them. In the Cited Journal Listing, a similar algorithm was adopted. The subentry lists are again to a maximum of 100 items or 85% of the total citations.

However, where either condition would allow listing of items citing less than four times in the year, the items are not printed as subentries but are incorporated in the ALL OTHER subentry. Disregarding these conditions, at least fifteen subentries in addition to the ALL OTHER subentry must be printed, if the main entry journal can supply them. (*SSCI*, 1984: 35A)

These editorial decisions create several problems for citation researchers.

b. 1) The differing cutoff points for citing and cited entries results in an unbalanced matrix. The *JCR* listings of citing and cited data are limited to 100 items or 85% of the total citations, after which if journals were listed that received fewer than 15 cites in a year, at least 6 journal titles must be printed, or, if journals were listed that made fewer than 4 cites in a year, at least 15 journal titles must be printed. The remainder are put into an ALL OTHER category (Table 4 provides an example). Hence, it is rare to be able to gather comparable amounts of citing and cited data for a given journal.

Table 4
Sample listings of citation data showing numbers of journals grouped as ALL OTHER because of the *JCR* cutoff algorithm

1978 Cited data		1984 Citing data	
J AM SOC INFORM SCI	291	Columbia Journal Rev	105
J AM SOC INFORM SCI	72	Columbia Journal Rev	19
ANNU REV INFORM SCI	28	New York Times*	10
INFORM PROCESS MANAG	19	Wash Post	7
J DOG	18	CJR SEP*	4
NAUCH-TEKN INFORM 2	15	CJR MAR*	3
J ASSOC COMPUT MACH	11	CJR MAY*	3
P AM SOC INFORM SCI	11	CJR JUL*	2
CAN J INFORM SCI	10	CJR NOV*	2
COLL RES LIBR	10	NEWSPAPERMAN SI NEWH	2
ON-LINE REV	8	WALL STREET J	2
SOCIO ECON PLAN SCI	8	ADVERTISING AGE	1
SCIENTOMTR	7	AM LAWYER	1
SPEC LIBR	6	ASS PRESS STYLEBOOK	1
B MED LIBR ASSOC	5	BATTLE PUBLIC OPINION	1
J CHEM INF COMP SCI	5	BIG STORY	1
SOCIOL INQ	5	ALL OTHER (46 journals)	46
J CLIN PHARMACY	5		
CURR CONTENTS	4		
ALL OTHER (30 journals)	44		

*These are aberrant abbreviations for *Columbia Journalism Review.*

b.2) Journals with names appearing earlier in the alphabet are more likely to be listed by name than are journals listed later. The requirement to list a certain minimum number of titles means that the latter part of the list is usually an alphabetic listing of journals with the same number of citations made or received (usually 1 or 2) and the list will be truncated after 6 or 15 items in the Citing and Cited listings, respectively. Again, this leads to a skewed dataset.

b.3) Journals in fields with relatively low numbers of citations will have fewer journal titles listed than will fields with higher citation rates. Few of the Communication and the Information Science and Library Science journals in our sample make 15 cites/year or more to any given journal, or receive 4 cites/year or more from any given journal. Thus, the sparse matrices are particularly susceptible to losing data from these cutoff algorithms. See Table 4 for examples.

Constructing more reliable citation data

This section describes in detail how we attempted to improve the reliability of the journal-to-journal citation data for our study.

The raw data collected from the *JCR* Citing and Cited listings were entered into a personal computer spreadsheets for each year, with consistent formats to facilitate comparisons and statistical analyses on the data set as a whole. The vertical and horizontal axes of each spreadsheet are labelled with the titles of the 95 journal titles. Communication journals are listed in alphabetical order, followed by a blank row and then an alphabetized list of Information Science and Library Science (IS&LS) journals. The vertical axis represents *Citing* journals, while the horizontal axis represents *Cited* journals. For ease in processing, we marked photocopies of the *JCR* listings in three ways – journal titles using the *SSCI* standard abbreviation and included in the 1985 listing, journals from prior years whose titles had changed by the the 1985 listing, and titles of journals on the 1985 listing but which had abberant abbreviations. On both axes of the spreadsheet matrix, 19 of the journal abbreviations are previous journal titles not represented in the 1985 listing of "Fully Covered Source Journals." They immediately follow the *SSCI* standard abbreviation of the journal which superceded them.

We illustrate the process of entering the Citing and Cited data into the spreadsheets using Citing and Cited listings for *Int Classif* (*SSCI*'s standard abbreviation for *International Classification*) and *ZBL Bibliothekewesen* (*SSCI*'s standard abbreviation for *Zentralblatt fur Bibliothekwesen*) from the 1977 *JCR* data, as shown in Table 5, selected to show some of the inconsistencies that exist in *JCR*'s presentation of the data.

Table 5
Sample citing and citing data for two journals, adapted from 1977 *JCR*

Citing journal / Cited journal	Total	Number of times this year was cited in 1977: 77	76	75	74	73	72	71	70	69	68	Rest
.08 Int Classif	143	14	26	13	12	7	7	5	6	3	7	43
a Int Classificat	7	5	0	0	2	0	0	0	0	0	0	0
c Am Doc	5	0	0	0	0	0	0	0	0	0	1	4
c Inform Storage Retr	5	0	0	0	0	1	0	0	1	0	1	2
b J Doc	5	1	0	0	1	0	1	0	0	1	0	1
b.08 Int Classif	4	0	2	0	2	0	0	0	0	0	0	0
b J Am Soc Infrom Sci	3	1	0	1	0	0	0	0	1	0	0	0
All others (102)	114	7	24	12	7	6	6	5	4	3	5	36
...	..	..	..	..	..	..	..	..	..	..	..	..
...	..	..	..	..	..	..	..	..	..	..	..	..
.04 Zbl Bibliothekewesen	861	27	118	106	91	58	44	19	40	30	21	307
a Zbl Bibl Wesen	98	11	14	13	8	9	6	2	6	4	2	23
c Istorija Bibliotecno	23	0	1	11	2	0	0	1	2	0	0	6
b.04 Zbl Bibliothekewesen	20	0	3	2	2	2	1	0	2	1	0	7
c Sov Bibliotekovendeni	17	0	2	5	6	2	0	0	0	0	0	0
a Zbl Bibl Wesen Leipz	12	2	2	3	3	0	0	0	0	1	0	1
...	..	..	..	..	..	..	..	..	..	..	..	..
...	..	..	..	..	..	..	..	..	..	..	..	..
a Int Classification	6	0	0	3	3	0	0	0	0	0	0	0
...	..	..	..	..	..	..	..	..	..	..	..	..
...	..	..	..	..	..	..	..	..	..	..	..	..
All others (480)	604	12	88	64	50	41	30	12	25	24	19	239

Cited journal / Citing journal	Total	Number of times this year was cited in 1977: 77	76	75	74	73	72	71	70	69	68	Rest
.08 Int Classif	4	0	2	0	2	0	0	0	0	0	0	0
b. .08 Int Classif	4	0	2	0	2	0	0	0	0	0	0	0
...	..	..	..	..	..	..	..	..	..	..	..	..
...	..	..	..	..	..	..	..	..	..	..	..	..
.04 Zbl Bibliothekewesen	20	0	3	2	2	2	1	0	2	1	0	7
b .04 Zbl Bibliothekewesen	20	0	3	2	2	2	1	0	2	1	0	7

[a] Abberant abbreviation.
[b] On *JCR*'s "Fully Covered Source Journals" list.
[c] Not on *JCR*'s "Fully Covered Source Journals" list, so not marked on photocopy of *JCR*, and not included in core totals.

Inputting CITING data

As the journal titles are arranged alphabetically within the spreadsheet, we consider the citing data for *International Classification* first. The entry for *Int Classificat* in Table 5 is marked with an "a" to indicate that this is an aberrant abbreviation which we have agreed to include in our data set. *Int Classificat* cited (i. e., self-cited) *Int Classif* 7 times. To find the proper cell for this entry, one scans down the vertical axis in the spreadsheet for the journal title *International Classification,* then scans across the corresponding row until the identical journal title is reached on the horizontal axis, and enters a 7.

The next value corresponds to *J Doc* (*SSCI*'s standard abbreviation for *Journal of Documentation*), marked with a "b" to indicate that it is on the FCSL list. The value 5 is entered in the cell with the Citing label (vertical axis) equal to *International Classification* and the Cited label (horizontal axis) equal to *Journal of Documentation*. The third marked entry is *Int Classif*. Moving to the appropriate cell in the spreadsheet, one will see that the value of 7 has already been entered. To this value, 4 more citations are added, so the value of 7 is replaced by a total of 11 citations made to *International Classification* by its variants. Finally, a value of 3 is entered in the spreadsheet for *International Classification* citing *J Am Soc Info Sci* (*SSCI*'s standard abbreviation for the *Journal of the American Society for Information Science*).

Now that all of the 1977 Citing data have been entered for the journal *International Classification,* it is necessary to calculate Citing totals. See Table 6 for explicit definitions of the various totals used in the spreadsheet.

The first Citing total that appears in the spreadsheet is, JCRCoreTtl (for Citing totals according to *JCR*), which represents the total number of citations that a core journal makes to other core journals in a particular year (in this example, 1977). JCRCoreTtl recognizes *only* those Citing values that are attached to *SSCI* standard abbreviations in the *JCR* volumes. Thus the 1977 JCRCoreTtl for Citing values is 5 citations to *J Doc*, 4 citations to *Int Classif,* and 3 citations to *J Am Soc Inform Sci,* for a JCRCoreTtl value of 12 for *International Classification.*

The second Citing total appearing in the spreadsheet is OurCoreTtl, which adds aberrant abbreviations to the total of JCRCoreTtl. Using our example, OurCoreTtl has a value of 19, representing the 12 citations made to core journals using *SSCI* standard abbreviations plus the 7 citations attached to the abbreviation *Int Classificat*, an aberrant abbreviation for the core journal *International Classification.* Since OurCoreTtl is simply the sum of all Citing values in a given row of the matrix, this figure can be calculated automatically by the spreadsheet by using a formula equivalent to:

@SUM(C57 . .CU57) where C57 and CU57 are the first and last cells, respectively, in the row of Citing values for *International Classification.*

The third Citing total in the matrix is JCRA11Ttl, representing *SSCI*'s calculated total of all citations made by a given journal in a given year. This total is provided

Table 6
Definitions of *JCR* and improved totals

Citing

JCRCoreTtl: total number of citations made in a given year to core journals, as represented by *SSCI* standard abbreviations.

OurCoreTtl: total number of citations made in a given year to core journals, including both *SSCI* standard and aberrant abbreviations; computed automatically by usingt the @SUM spreadsheet function.

JCRAllTtl: total number of citations made in a given year to any journal; taken directly from each journal's Citing total as listed in *JCR*.

OurAllTtl: same as JCRAllTtl.

Cited

JCRCoreTtl: total number of citations made to the journal in question by other core journals in a given year, excluding citations attached to aberrant abbreviations and citations appearing only in Citing listings; the sum of all marked subentries in the journal's Cited listing.

OurCoreTtl: total number of citations made to the journal in question by other core journals in a given year, including citations attached to aberrant abbreviations and citations appearing only in Citing listings due to *SSCI*'s inclusion algorithm, computed automatically by using the @SUM spreadsheet function. While more accurate than JCRCoreTtl, OurCoreTtl (for both Citing and Cited) will not include citations omitted in both the Cited and Citing listings due to *SSC's* inclusion algorithms.

JCRAllTtl: total number of citations received by the journal in question in a given year, excluding citations attached to aberrant abbreviations; taken directly form each journal's Cited total as listed in *JCR*.

OurAllTtl: total number of citations received by the journal in question in a given year, including citations attached to aberrant abbreviations. It is the sum of JCRAllTtl and all values in the spreadsheet column that were attached to aberrant abbreviations. While more accurate than JCRAllTtl in representing the total number of citations received, OurAllTtl does not take into account the potentially large number of aberrant citations from non-core journals.

in the *JCR* Citing listings at the top of each journal's entry. The Citing listing for *International Classification* indicates that a total of 143 citations were made by the 1977 issues of this journal.

The final Citing total, OurAllTtl, will always be equal to JCRA11Ttl described above. OurAllTtl takes on greater significance for the Cited totals, to be explained shortly. All relevant Citing data for *International Classification* has now been entered into the spreadsheet. Data entry for all other journal titles follows the same pattern.

Inputting CITED data

Cited data is entered along the spreadsheet column labelled corresponding to *International Classification*. The *JCR* Cited listing indicates that this identically named journal received a total of 4 citations in the year 1977, and all of them were self-citations. If we scan down the column for this journal title until it intersects with the row for the same title, we will find that a value of 11 has already been entered into the corresponding cell. Recall that the value of 11 represents the 4 citations to *Int Classif* plus the 7 citations to *Int Classificat,* an aberrant abbreviation. Since the 4 citations presented in the *JCR* Cited listing are already represented in the cell value, there is no need to alter the cell value in any way. And, since there are no other Cited values to be considered for *International Classification,* we may now proceed to the Cited totals.

As mentioned above, *JCR* Cited listings will contain no references to aberrant abbreviations. In other words, all journals referenced in the Cited listings will employ journal abbreviations as they appear in the prefatory materials of *JCR*. Consequently, the Cited JCRCoreTtl is always equal to the sum of all marked items in the corresponding Cited listing. For example, the number of core journals that cited *International Classification* in 1977 (i. e., JCRCoreTtl) is 4. Since only *SSCI*-recognized abbreviations occur in the Cited listings, the Cited OurCoreTtl will not differ from JCRCoreTtl as a result of aberrant abbreviations. For *International Classification,* the Cited OurCoreTtl (calculated with the @SUM or an equivalent function) is also equal to 4. In this example, JCRCoreTtl equals OurCoreTtl.

This need not always be the case, however. Given the structure of the cutoff algorithms explained previously, it is common to have data relevant to our core journals appear in the Cited listings but not in the Citing listings, and vice-versa. For example, in 1981 *Wilson Library Bulletin* made 360 additional cites to 347 unspecified journals, because all these journal titles received 2 or less cites *and* come after the cutoff journal, *Encyclopedia Britannica*. This represents 73% of the total 492 cites this journal made. For another example, in 1980, was cited 3 times by and once by *Communication*. However, neither appears in the Citing list because (a) *Communication* was not a fully covered journal in 1980, and (b) *Public Opinion Quarterly* did not cite *Columbia Journalism Review* at least 5 times. When this occurs, JCRCoreTtl will differ from OurCoreTtl. JCRCoreTtl represents only those values presented in the Cited listing or Citing listing, as appropriate.

OurCoreTtl, on the other hand, represents all citations to or from core journals, regardless of whether they are represented in a Citing listing, Cited listing, or both. Since OurCoreTtl is calculated automatically by the spreadsheet, the figure is kept up-to-date as additional values are inserted in the spreadsheet.

The Cited JCRA11Ttl is taken directly from the Cited listing for each of our core journals. The 1977 Cited listing for *International Classification* presents a JCRA11Ttl value of 4.

The Cited OurAllTtl is the sum of JCRAllTtl and any values in the Cited column that were generated by aberrant abbreviations in the Citing listings. In order to calculate this value, it is necessary to scan the column of values and isolate any cell entries that differ from the data provided in the Cited listing of the corresponding journal. For example, if one were to scan the column of Cited data for *International Classification,* one would see that the value of 11 that appears in the row for this journal title differs from the value of 4 that appears in the journal's Cited listing. By examining the citing listing of *International Classification,* it would become clear that the additional 7 citations are attributable to the use of an abberrant abbreviation. Therefore, one would add these 7 citations as well as any other "aberrant" citations in the column to JCRA11Ttl to arrive at a figure for OurAllTtl. appears in a cell and the data that appears in the Cited listing may be due to *SSCI*'s listing algorithm, in which case the value for OurAllTtl is not increased beyond that for JCRAllTtl, because data cut off by the algorithm is represented in the Cited listing under ALL OTHER, and hence is already repersented in JCRAllTtl. Note also that OurAllTtl is biased in facor of core titles, because non-core journals in the discipline are not compensated for being cited by journals not included in JCR's fully covered list.

Table 7 provides three examples of the range of differences between raw *JCR* and improved journal-to-journal citation data, cited data only, along with summary definitons of the raw and corrected variables.

Table 7
Examples of differences for cited totals, 1979 data

		JCRCoreTtl	*OurCoreTtl*	*JCRAllTtl*	*OurAllTtl*
American Archivist	a	18	87	35	104
Aslib Proceedings	b	95	100	114	118
Quarterly Journal of Speech	c	189	191	273	273

[a]The difference of 69 between JCRCoreTtl and OurCoreTtl is due to 69 citations to aberrant abbreviations for *American Archivist,* found throughout the 1979 Citing listings. These additional citations are also carried over to OurAllTtl.

[b]The difference between JCRCoreTtl and OurCoreTtl represents 4 citations to aberrant abbreviations for *Aslib Proceedings* plus 1 citation to *Aslib* which was omitted from *Aslib*'s Cited listing due to *SSCI*'s listing algorithm. Only the 4 citations relating to aberrant abbreviations are added to JCRAllTtl to yield OurAllTtl.

[c]OurCoreTtl includes 2 citations present in the Citing listing for *Journal of Technical Writing,* but omitted from *Quarterly Journal of Speech*'s Cited listing in *JCR* as a result of *SSCI*'s listing algorithm.

Table 8
Summary statistics of citing and citing totals, comparing *JCR* to improved totals

Variable		1977	1978	1979	1980	1981	1982	1983	1984	1985
Citing:										
OurCore-JCRCore	a	9.58	8.54	8.79	9.25	8.94	10.49	9.17	12.10	14.63
JCRCore	a	33.08	29.53	36.15	40.65	40.72	40.91	51.55	47.35	55.37
Diff/JCRCore	b	0.29	0.29	0.24	0.23	0.22	0.26	0.18	0.26	0.26
Cited:										
OurCore-JCRCore	a	5.98	7.14	7.54	7.56	5.52	5.54	6.86	5.66	14.25
JCRCore	a	43.36	38.68	45.81	50.76	50.61	52.37	61.89	60.58	55.90
Diff/JCRCore	b	0.14	0.18	0.16	0.15	0.11	0.11	0.11	0.09	0.25
OurAll-JCRAll	a	6.07	6.97	4.70	4.33	5.21	4.76	0.77	3.37	6.29
JCRAll	a	135.46	128.49	109.80	114.23	126.36	119.08	121.86	126.15	118.32
Diff/JCRAll	b	0.04	0.05	0.04	0.04	0.04	0.04	0.01	0.03	0.05

a. Mean.
b. The average difference between the prior two totals (OurCore and JCRCore, or OurAll and JCRAll), divided by the average *JCR* citing or cited value.

Table 8 provides the summary statistics on the extent of these kinds of reliability issues, by comparing the *JCR* average citing and cited totals to the corrected citing and cited totals, for core Communication and core IS&LS journals 1977 through 1985. For each year, the difference in the average totals was computed, then divided by the *JCR* average, for citing core figures, cited core figures, and cited overall figures.

The extent of the difference (1) in the average core *citing* totals is about 25% per year over the 9-year period, (2) in the average core *cited* totals about 15%, and (3) in the average overall *cited* totals about 4%. Note that the second figure underestimates the potential measurement error for cited totals because the total does not include citations from non-ISI journals, and the last figure underestimates the potential measurement error for all journals, because, of course, we have corrected the figures only for the core Communication and Information Science and Library Science journals.

Our data suggest that the *JCR* totals considerably underestimate the actual citing and cited totals in journal-to-journal citation data. While these percentages by themselves are rather considerable, it is up to the researcher to decide whether use of the journal-to-journal citation data as published in the *JCR* would significantly affect conclusions that are, after all, generally focussed upon the most frequently cited and citing journals which would be less affected by these sources of error.

Discussion

Here we summarize our suggestions for improving the reliability of *JCR* journal-to journal citation data. Some of these appeal directly to the producers of the *JCR*, but researchers may have to attempt these improvements themselves.

Include prior titles

Citation data for variant journal titles represent legitimate data which should not be ignored. Examine similar journal titles through various bibliographic sources and serials records to determine dates of publication and whether earlier titles exist. When earlier titles exist, create a separate column in the data matrix, which allows for more efficient error-checking. This is most easily done for journals that continue directly from a prior journal. For journals that split or merge, a footnote on the bibliographic history of the title would be helpful.

Include data attached to aberrant abbreviations

The lack of standardization in *SSCI*'s abbreviations for core journals requires the inclusion of all data which are meant to represent a core journal, whether or not the data are attached to *SSCI*' s standard abbreviation for that journal, because data attached to aberrant abbreviations are not recognized by *SSCI* in the calculation of its Citing and Cited totals for core journals.

Gather data from both citing and cited listings

SSCI lumps small Citing and Cited data values into a single value called ALL TOTAL, based on its cutoff algorithm. The implication of this is that a data value may appear in the Citing value complete with its corresponding journal title, while the same piece of data is hidden in the Cited ALL TOTAL listing. The reverse situation may also be true. Consequently, examine *both* the Citing and Cited listings in order to gather the most accurate account of relevant citations.

Identify missing citing and cited data for "Fully Covered" titles

A journal listed in *SSCI*'s list of "Fully Covered Source Journals" will not always receive a Citing or Cited entry in that particular edition of *JCR*. This raises doubt as to the actual meaning of "Fully Covered," and also fosters concern over the care with which the listings are constructed. It may be necessary to treat all data appearing in one year's listings under another year's abbreviations as "standard" data.

Consider the definition of core journal

For our study, we used *SSCI*'s definition of a "core" journal as a journal included in *SSCI*'s subject listing (prior titles need not be present in the list to be considered a member of the core). While greatly facilitating the collection of journal citation data, this method of determining core membership may cause four classes of problems. First, some "potential" members (for example, for the current study, *International Journal for Man-Machine Studies* and *UNESCO Journal of Information Sicence*) may be ignored because *SSCI* decided to list them in a different subject category. Second, the JCR core lists may include titles that may not be accepted by the typical researcher or practitioner in that discipline (such as *Journal of Technical Writing and Communication*). Third, in some cases journals may be listed as a member of more than one "core" (such as *Telecommunications Policy,* which is listed in both the

Communication and the Information Science and Library Science core). Finally, because the *JCR* does not define its criteria for this core membership, the validity of the "core" list is uncertain.

Conclusion

As *Edge* (1979), *Garfield* (1979), *Smith* (1981) and others have argued, because of the many questionable assumptions and sources of error in citation analysis, this bibliometric method should be used to complement, not replace, other approaches to understanding the social structure of scientific communities, even though *Cole & Cole* (1971) provide good evidence of the conceptual validity of citation data. Here, using nine years' worth of citation data involving nearly 76 journals in Communication, Information Science and Library Science, we have shown that the reliability of journal-to-journal citation data taken from the Institute for Scientific Information's *Social Science Citation Index Journal Citation Report* may suffer from at least 25% measurement error. ISI may be able to resolve some of these threats to the reliability of their journal-to-journal citation data, while researchers must also take steps to improve the data they use from such sources. We have suggested ways to correct many of the causes of this error. Some positions on the validity of citation data may be obscured by problems with its reliability.

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