Review of Self-Citation Research: Questioning, Verification, and Innovation in Scientific Evaluation and Communication (Postprint)

Authors: Wen Fangfang

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Abstract

[Purpose/Significance] Self-citation is originally a common phenomenon in scientific communication, yet it has become embroiled in long-standing controversy regarding scientific evaluation. A review of self-citation research helps deepen scholars' understanding and knowledge of self-citation, dispel prejudices and misconceptions about it, and stimulate sustained attention and reflection on this topic. [Method/Process] Through systematic investigation and analysis of relevant domestic and international literature, this study objectively describes the development history and current status of self-citation research, traces its academic lineage and evolutionary trajectory, summarizes main achievements and ideas, identifies existing problems in current research, and predicts future research priorities and directions. [Results/Conclusion] Self-citation research has undergone long-term questioning and repeated verification and remains inconclusive to date; disagreements stem from differences in research perspectives. Self-citation research urgently requires new breakthroughs, with its focus shifting from mere bibliometric and statistical analysis to in-depth exploration and analysis of the patterns and mechanisms underlying the data; the function of self-citation in examining academic inheritance and knowledge diffusion will also be further explored.

Full Text

Preamble

A Review of Self-Citation Research: Questioning, Verification, and Innovation in Scientific Evaluation and Scientific Communication

Wen Fangfang
School of Management, Henan University of Science and Technology, Luoyang 471023

Abstract

[**Purpose/Significance**] Self-citation is a common phenomenon in scientific communication, yet it has long been controversial in the context of scientific evaluation. This review of self-citation research helps enhance scholars' understanding of self-citation, clarifies biases and misunderstandings about it, and inspires continued attention and reflection on the topic. [**Method/Process**] Through systematic investigation and analysis of relevant domestic and international literature, this paper objectively describes the development history and current status of self-citation research, traces its academic context and evolutionary trajectory, summarizes main findings and ideas, identifies existing problems in current research, and predicts future research priorities and directions. [**Result/Conclusion**] Self-citation research has experienced long-term questioning and repeated verification without reaching a definitive conclusion, with disagreements stemming from differences in research perspectives. Self-citation research urgently needs new breakthroughs, with its focus shifting from simple measurement and statistical analysis to in-depth exploration and analysis of the underlying patterns and mechanisms behind the data. The function of self-citation in examining academic inheritance and knowledge diffusion will also be further explored.

Keywords: self-citation; scientific communication; scientific evaluation; citation-based indicators

Self-citation is a natural phenomenon in scientific communication, yet it has been subject to intense questioning and controversy in scientific evaluation. As E. Garfield stated, "self-citation is neither good nor bad" [1]; what matters is how we view and utilize it. Science presents a clear academic trajectory and lineage through the citation system, and self-citation is no different from citations by others in reflecting the coherence and continuity of scientific research [2]. However, as citation indicators are increasingly applied in scientific evaluation activities—such as journal selection, publication of results, grant awards, professional promotion, and research rewards—citations have become tightly bound to interests. When citation indicators accumulate such enormous power, scholars have expressed concerns and doubts about whether they can still objectively reflect the true face of science and whether they might deviate from their original track through manipulation. Compared to citations by others, self-citation is more susceptible to human manipulation and has thus become the primary target of scholars' criticism and questioning. Over the decades, numerous articles on self-citation have emerged both domestically and internationally, with some defending it and others adding new "evidence" against it. This prolonged debate remains unresolved.

Many bibliometricians, with their keen sense of measurement and evaluation, have conducted bold hypotheses and careful verification, examining the universality and particularity of self-citation in scientific communication from multiple perspectives and calculating and testing its impact on scientific evalua-

tion. Some scholars have explored the patterns of knowledge exchange and diffusion, as well as the context and evolution of academic inheritance, through self-citation relationships. After extensive reading and systematic review of the literature, I have summarized the main viewpoints and findings and consulted with some experts and scholars. These achievements faithfully record scholars' persistent exploration of self-citation issues over decades—questioning out of concern, verifying through questioning, clarifying through verification, expecting through clarification, and innovating through expectation. The findings contain a wealth of valuable ideas, viewpoints, methods, data, and discoveries, which I have extracted and woven into this research review to trace the development history and current status of self-citation research and predict future trends and directions.

2 Self-Citation: An Inevitable Result of Scientific Communication

2.1 Universality of Self-Citation

Self-citation typically refers to cases where citing and cited documents share the same author (author self-citation). This definition can also be extended to other citation relationships, such as when citing and cited documents come from the same journal (journal self-citation), the same discipline (disciplinary self-citation), the same language (language self-citation), the same institution (institutional self-citation), or the same country (national self-citation). Among these, author self-citation and journal self-citation have received the most attention. Self-citation is an organic component of the citation system and, like other citation phenomena, can be analyzed using mathematical tools and models [3]. After a paper is published, its references are fixed, while the citations it receives continue to accumulate dynamically. Therefore, S. M. Lawani suggested examining self-citation from both synchronic and diachronic perspectives, dividing it into synchronous and diachronous self-citation and measuring it using two indicators: self-citing rate and self-cited rate [4]. Author self-citing rate refers to the proportion of self-cited references in an author' s total references, while self-cited rate refers to the proportion of self-citations in an author' s total received citations. ISI defines journal self-citing rate as the proportion of references in a journal that come from the same journal, and self-cited rate as the proportion of citations received by a journal that come from the same journal. For example, if a journal self-cites a times, cites other journals b times, and is cited by other journals c times, then the journal' s self-citing rate is $a/(a+b)$ and its self-cited rate is $a/(a+c)$.

Early studies primarily calculated self-citation rates to examine the universality of self-citation. E. Garfield noted that self-citation accounts for approximately 10% of all citations when only first authors are counted, with the proportion increasing when all co-authors are included [5]. M. H. MacRoberts believed self-citation accounts for about 10%-30% of all citations [6]. M. L. Wallace et

al.' s statistics showed self-citation rates of about 10%-36%, with significant disciplinary differences [7]. H. Snyder and S. Bonzi' s results indicated that approximately 9% of all citations are self-citations, with rates of 15%, 6%, and 3% in physics, social sciences, and humanities, respectively [8]. R. Tagliacozzo found self-citation rates of 16.6% and 17.5% in plant physiology and neurobiology [9]. M. Y. Tsay, using high-volume journals in the semiconductor field as samples, calculated average self-citing and self-cited rates of 9.59% and 15.03%, respectively [10]. M. Leblond calculated a self-citation rate of 12.8% for ecology journals [11]. W. B. Lievers and A. K. Pilkey, examining nine journals in economics, computer science, pharmacy, and biology, found that the proportion of self-citing articles ranged from 62.4% to 95.1% (average 76.2%), while journal self-citation rates ranged from 4.8% to 13.4% (average 9.9%), with average rates of 5.9%, 11.0%, and 12.4% across the three disciplines [12].

These data demonstrate that self-citation rates vary by discipline, journal, and statistical timeframe, method, and sample size, with common rates of approximately 10%-40% in the overall citation system [13]. In addition to disciplinary differences, self-citation rates are influenced by multiple factors including coauthorship, publication volume, author age, citation window, language, and publication type. S. Mishra et al. summarized and compared various factors, concluding that self-citation is primarily constrained by the visibility and accessibility of documents and their authors and journals, while cultural or gender effects are secondary [14]. Multiple statistical results confirm that self-citation is indeed a universal phenomenon and an important component of scientific communication. This has become the focal point of debate: one view holds that such high self-citation rates must significantly impact citation-based evaluation indicators, causing distorted evaluation results and thus self-citation should be excluded from scientific evaluation; another view argues that because self-citation accounts for such a large proportion, removing it would destroy the integrity of the citation system, leading to another extreme form of bias and misguidance in evaluation results.

2.2 Motivations for Self-Citation

A. N. Larcombe and S. C. Voss consider self-citation reasonable and necessary, as authors draw on methods, viewpoints, and conclusions from their previous work to support current research. In some specialized fields that are relatively unique or independent, it is difficult to obtain many external references, making substantial self-citation inevitable. Self-citation for these reasons is not inappropriate and its motivations are not significantly different from those for citing others [15]. P. Pichappan and S. Sarasvadhy, however, believe self-citation motivations differ from those for citing others, including: continuing previous research, increasing visibility of early work, indicating follow-up research, self-promotion of low- or zero-cited early work, supplementing new evidence for previously incomplete or controversial viewpoints, impressing reviewers and editors, building reader confidence and expectations, and artificially inflating one'

s citation counts [16]. J. Hartley listed several self-enhancement motivations: self-aggrandizement—intentionally telling reviewers and readers about previous publications in high-level journals; self-promotion—citing one' s own books to boost sales; and self-advertising—citing one' s own articles to increase their visibility and attract attention and citations from other scholars [17]. Such self-citations, regardless of similarity or relevance between citing and cited documents, have questionable motivational legitimacy. As for journals and authors who deliberately self-cite to improve their citation performance in scientific evaluations and obtain status and honors inconsistent with their true capabilities, such self-citations for utilitarian purposes can be definitively judged as inappropriate [18].

K. Hyland and F. Jiang categorized self-citation motivations into two types: objective needs for the continuity and coherence of scientific research, and subjective needs of authors or journals to deliberately enhance citation performance [19]. The former is considered legitimate self-citation, while the latter is viewed as inappropriate, a distinction scholars generally agree on. However, the real problem lies in the difficulty of identifying true motivations [20]. Often, legitimate and inappropriate self-citation are not clearly demarcated, and inappropriate self-citation behavior has a certain degree of concealment that makes accurate distinction and judgment difficult for anyone except the authors themselves. Chinese scholar Zhu Daming summarized criteria for distinguishing legitimate from inappropriate self-citation, arguing that the key lies in academic integrity [21].

3 Self-Citation: A Disruptive Factor in Scientific Evaluation

3.1 Self-Citation and Journal Impact Evaluation

3.1.1 Strategic Means to Enhance Journal Impact E. Garfield proposed the Journal Impact Factor (JIF) indicator in 1955 to help librarians and scientists improve procurement and retrieval efficiency. The first JIF ranking was published in 1972, after which JIF was widely applied in scientific evaluation. Despite mixed academic opinions, as C. J. A. Bradshaw and B. W. Brook stated, whether you like it or not, using JIF to evaluate journals and related research performance is an objective and widespread practice; whether it is correct or not, author submissions, journal prestige, and publisher performance are all closely related to JIF [22]. Natural loopholes in JIF calculation methods make both its numerator and denominator easily manipulable, especially as JIF becomes increasingly tied to real-world interests, leading to great skepticism about its scientific validity and effectiveness [23]. Scientists' research patterns and journals' publishing strategies have even changed accordingly. For higher academic prestige and perhaps due to publisher economic pressures, some journals resort to strategic schemes to boost JIF: first, artificially increasing self-citation by extensively citing articles published in the journal in the past two years—authors

self-citing to please editors or editors instructing authors to self-cite, both theoretically helping to increase JIF; second, forming "citation clubs" where journals extensively cite each other' s literature, a behavior more covert than self-citation and immune to self-citation removal; third, publishing large numbers of editorials and letters, since JIF denominators only count articles and reviews while numerators include citations to all document types; fourth, selectively screening submissions, prioritizing well-known scholars, institutions, and internationally co-authored papers that editors deem more likely to receive citations.

3.1.2 Impact of Self-Citation on Impact Factor Metrics Theoretically, self-citation can artificially inflate citation counts and increase impact factors. Scholars have conducted extensive tests on whether this occurs in reality, yielding varied conclusions.

(1) Positive Impact. J. M. Campanario calculated JIF before and after removing self-citations and found significant changes in journal rankings [24]. J. M. Campanario and L. González' s research showed that inappropriate self-citation could cause impact factor inflation of 30%-40%, even in highly prestigious journals [25]. J. K. Vanclay confirmed that strategic self-citation can indeed increase citation counts, but emphasized this is a supplementary rather than alternative solution, effective only in the short term, with scientific impact fundamentally depending on paper quality rather than other factors [26].

(2) Negative Impact. M. Mimouni, using pediatric journals as an example, demonstrated that JIF is significantly negatively correlated with self-citation rate, arguing that claims of JIF manipulation through self-citation lack effective evidence [27]. T. F. Frandsen, using social science journals as an example, found that when journal self-citation rates increased, JIF not only failed to increase but actually decreased [28].

(3) No Impact. A. F. J. van Raan acknowledged that self-citation is a phenomenon that cannot be ignored, but argued it does not inflate JIF [29]. J. M. Campanario studied journals with continuously increasing JIF and found that the growth was not caused by self-citation, which contributed little to JIF, with no evidence that excessive self-citation leads to JIF inflation [30]. M. H. Huang and C. W. Y. Lin, using environmental engineering journals as an example, found no significant changes in JIF or Journal Immediacy Index (JII) after removing self-citations, with no significant correlation between JIF and self-citation rate [31]. A. W. K. Yeuan argued that JIF is unrelated to self-citation rate, recommending multiple indicators for journal impact evaluation rather than relying on a single metric [32].

(4) Conditional Impact. X. D. Xia and Y. W. Wu, using 222 Chinese journals as examples, found that journal self-citation rate was significantly positively correlated with JIF in some years but not in others, concluding that moderate self-citation is necessary but should not be deliberately encouraged or required [33]. R. Giri found that self-citation has a more significant impact on low-level

journals than on high-level journals [34].

3.1.3 Whether Impact Factor is Manipulated through Self-Citation G. Yu and L. Wang pointed out that while self-citation rate theoretically affects JIF, reality often diverges from theoretical predictions, making JIF manipulation through self-citation feasible for some journals but not others [35]. J. M. Campanario and A. Molina' s research supported JIF' s robustness, acknowledging that strategic schemes to boost JIF exist but are uncommon, and that JIF remains an effective indicator reflecting journal quality and impact [36]. A. Andrade et al. selected journals with significant JIF growth to examine whether this growth was caused by self-citation, finding that most journals' JIF growth did not depend on self-citation, with only a very small number of journals where the growth rate of self-citation impact factor was significantly greater than the growth rate of other-citation impact factor, leading them to conclude that claims of JIF manipulation through self-citation lack effective evidence [37]. Liu Xueli confirmed that Chinese SCI-source journals show no obvious manipulation [38]. Zheng Yi' s research showed that while artificially increasing self-citation can raise JIF, the effect is limited and does not improve journal quality [39]. These studies only deny the universality of JIF manipulation; inappropriate self-citation still occurs frequently in practice.

One survey indicated that about 20% of surveyed journals were involved in inappropriate citation to varying degrees, with fewer than 7% of authors refusing when faced with forced self-citation requests from editors [40]. J. Krauss listed six journals with forced self-citation behavior, finding that while overall journal self-citation rates did not increase universally, these six journals' self-citation rates did increase significantly [41]. T. Yu identified 48 journals with forced self-citation through investigation [42]. JCR removed 250 journals between 2007-2014 on the grounds that "excessive self-citation had affected JIF validity, preventing it from reflecting true journal impact" [43].

3.2 Self-Citation and Individual Impact Evaluation

3.2.1 Can Author Self-Citation Affect the h-index? Since its inception, scholars have continuously discussed the risk of h-index manipulation, proposing numerous improved indicators including the g-index, w-index, π-index, e-index, and dozens of others. While journal self-citation debates focus on its impact on JIF, author self-citation concerns its impact on the h-index. J. E. Hirsch acknowledged that self-citation can increase total citation counts, but argued that since the h-index depends on both publication quantity and citation quantity, simply changing citation quantity cannot significantly affect the h-index [44]. Clearly, Hirsch' s defense is unconvincing. Multiple scholars have tested the h-index and its variants, finding that self-citation significantly impacts the h-index, which decreases by an average of 12% after removing self-citations, with an even greater impact on the g-index [45-47]. R. J. C. Brown calculated h-index before and after removing self-citations, finding significant differences and

recommending self-citation exclusion when calculating h-index, proposing the corresponding b-index [48]. G. A. Văiu tested the robustness of the h-index and its 18 variants, finding each faces varying degrees of manipulation risk, recommending combined use of multiple indices for mutual verification [49]. However, M. H. Huang and C. W. Y. Lin found that self-citation has minimal impact on h-index values and rankings [50].

3.2.2 Degree of Impact of Author Self-Citation on h-index The key issue is not whether author self-citation affects the h-index, but the degree of impact [51]. C. Bartneck and S. Kokkelmans used machine learning methods to create two fictional authors—one using abnormal means to deliberately increase self-citations and the other using random strategies—then simulated their annual publication and citation patterns. Results showed that after 20 years, the two authors' h-indices reached 19 and 15, respectively, demonstrating that strategic self-citation can indeed increase h-index, with the strategy being more suitable for authors with low publication and citation volumes whose smaller h-index bases make them more sensitive to self-citation [52]. R. H. Gálvez found that after removing self-citations, senior scholars' h-indices decreased by 20% while junior scholars' decreased by 40% [53]. S. R. Huston found that senior authors have higher self-citation frequencies and rates than junior authors because they have more accumulated prior work to cite [54]. Scholars have also confirmed the "self-promotion" effect of self-citation in increasing citations by others: J. H. Fowler and D. W. Aksnes noted that each additional self-citation can increase citations by others by 1 after one year, 3 after five years, and 3.65 after ten years; although the current proportion of self-citations is only 11%, due to cumulative effects, 40% of total citations after ten years will indirectly come from self-citations [55]. M. H. Medoff, examining the impact of self-citation on authors' subsequent work, found that self-citation has a more significant impact on citations by others and total citations when the citation window is short, indeed increasing citation frequency of authors' subsequent work within five years, but having no effect beyond five years [56]. Even if self-citations are excluded when calculating citation indicators, the fact that self-citation can increase citations by others cannot be eliminated, and we cannot distinguish which citations by others result from self-citation.

3.3 Prolonged Questions and Debates

3.3.1 Does Self-Citation Distort Citation Metrics? Debates about self-citation focus on whether it can reflect true impact and the extent to which it may distort citation metrics, thereby affecting their validity [57]. H. L. Fang compared journals with excessive self-citation and zero self-citation, finding that zero-self-citation journals are not necessarily top-tier, while journals like *Science* and *Nature* also have certain proportions of self-citation [58]. J. P. A. Ioannidis pointed out that even if self-citation can interfere with citation metrics, it does not mean self-citation is inherently negative; in many cases it is reasonable and even necessary [59]. Pan Yuntao and Wu Yishan argued that author self-citation

is unavoidable, as even Nobel laureates have some self-citation, though at low proportions of total citations; normal self-citation is essential for clarifying the context of scientific research; each discipline has its own self-citation patterns, and deliberately increasing or avoiding self-citation against disciplinary norms is undesirable [60]. Meanwhile, inappropriate self-citation occurs frequently in practice—for example, one author self-cited 26 times in a single article, and a group of authors had a self-citation rate of 59% [11]. M. Mussard and A. P. James reported a typical case in the 2017 Times Higher Education World University Rankings, where India' s Vellore Institute of Technology ranked 43rd in Asia with the highest citation frequency in Asia, all due to one "highly cited" professor, S. Vaidyanathan. Statistics showed that 86% of the university' s citations came from this professor, whose total citations were 15,485 but whose self-cited rate was as high as 96% [61]. Abnormal self-citation not only inflates individual impact but also distorts university evaluation results.

3.3.2 Should Self-Citation be Excluded in Scientific Evaluation? Some scholars argue that only citations by others can demonstrate the impact of documents, journals, and authors in the scientific communication system, and that self-citation has little value for scientific impact evaluation [62]. P. Pichappan believes that while self-citation' s impact cannot be completely denied, it is at least limited [63]. Considering that self-citation lacks external impact and carries manipulation risks, some suggest excluding self-citation in scientific evaluation and measuring journal and author impact only through citations by others [64]. Others oppose this approach: excessively high self-citation rates indicate low visibility, relative isolation, and lack of communication of scientific achievements, but zero self-citation suggests current research lacks proper grounding [65]. In reality, few scholars have never cited their own work; appropriate self-citation precisely demonstrates stable research direction and continuous research work. If a journal is not even cited by its own authors, how can it attract citations by others? Negating self-citation is paradoxical and contrary to scientific communication patterns [66]. Inappropriate self-citation is only an isolated phenomenon without major overall impact, and considering the universality of self-citation and its large proportion in the overall citation system, blind removal may cause another form of distortion, still failing to truly and objectively reflect scientific impact [67].

Regarding whether to exclude self-citation, scholars hold different opinions based on empirical tests: S. Carley confirmed that self-citation significantly impacts citation evaluation results at both macro and micro levels [68]. M. Dunajski, using distinguished computer scientists as examples, proved that self-citation significantly impacts multiple citation indicators including the h-index and g-index, arguing that removing self-citation helps improve indicator accuracy [69]. C. G. Yheulon, using minimally invasive surgery scholars as examples, found that author self-citation has minimal impact on citation indicators like the h-index and is unnecessary to remove in individual research performance evaluation [70]. W. Glänzel' s research showed that at the national

level, self-citation has little impact on citation indicators and need not be removed [71]. D. Z. Zhao' s research indicated that self-citation is mostly motivated by legitimate reasons and has greater metric value than citations by others, arguing that scientific evaluation should not only retain self-citation but assign it greater weight, comparing the removal of self-citation to "throwing the baby out with the bathwater" [72]. A third, more conservative voice suggests that neither complete removal nor inaction is advisable, recommending that both indicators including and excluding self-citation be provided when calculating citation metrics to better understand the complexity of scientific communication [13]. Currently, JCR provides both JIF indicators with and without self-citation, and Scopus provides both h-indices with and without self-citation, indicating that major databases also hold a cautious attitude toward self-citation.

3.3.3 How to Identify Inappropriate Self-Citation Identifying inappropriate citations through complaints, reports, or social surveys may work for individual cases but lacks broad applicability [73]. Monitoring abnormal changes in self-citation patterns from a bibliometric perspective offers a more feasible approach. E. Garfield proposed 20% as a standard for legitimate self-citation, with journals exceeding 20% suspected of excessive self-citation [74]. JCR also uses 20% self-citation rate and 50% two-year self-citation rate as references when identifying journals with inappropriate self-citation. B. Z. Iliev advocated setting an upper limit for self-citation frequency, treating citations above the limit as abnormal and either excluding them or reducing their weight in scientific evaluation [75]. Obviously, this approach does not consider disciplinary differences and the particularities of certain journals. C. Humphrey argued that normal self-citation rates should remain relatively stable, and suspected excessive self-citation should be identified by monitoring changes over time rather than judging by absolute values [76]. Sudden annual increases or continuous multi-year growth in self-citation rates suggest potential excessive self-citation [77]. Jin Tiecheng suggested comparing self-cited rate with two-year self-cited rate, considering large differences between them as abnormal, reasoning that without manipulation the two indicators should be roughly equal, unless authors deliberately increase recent self-citations to boost JIF, causing abnormal two-year self-cited rates [78]. Other scholars suggest using expert judgment for source control, as journal editors and reviewers are familiar with literature in their field and can identify and correct inappropriate self-citation during the review process [79]. J. W. Flatt recommended self-citation transparency, requiring honest reporting of journal and author self-citation status under academic community supervision to deter inappropriate self-citation and prevent its spread [80].

4 Self-Citation: A Special Mode of Knowledge Diffusion

4.1 Self-Citation Originates from the Continuity of Knowledge Production

Scientific publications constitute a massive knowledge diffusion system, with citations playing an active role in promoting researchers' acquisition of new knowledge [81]. While strategic schemes may affect authors' citation behavior and citation indicator validity as citations are widely used in scientific evaluation, inappropriate self-citation is not inherent to scientific communication but rather an abnormal phenomenon arising at a certain stage of scientific development when scientific evaluation over-relies on citation indicators. Although individual authors and journals may adopt strategic means to increase self-citation, this should not deny the scientific validity and effectiveness of self-citation in examining knowledge exchange. R. Costas argued for a dialectical view of self-citation: from a scientific evaluation perspective, it is a factor causing evaluation distortion, while from a scientific communication perspective, it is a natural component of knowledge exchange [82]. Although self-citation has some self-recommendation and dissemination effects, scientific impact fundamentally depends on citations by others rather than self-citation [83]. Citations reflect interactions among scientific concepts and methods across documents, showing the scientific evolution process, and self-citation is no exception [84]. Author self-citation marks the stability of scientists' research directions and the continuity of research outcomes, reflecting the extension and expansion of research work [85]. As continuous publications, scientific journals should maintain relatively stable readership and authorship. Scholars' long-term attention to, reading of, and citation of certain journals, and their publication of articles in these journals, reflect both the high consistency between article topics and journal scope and authors' recognition of journal quality and impact. Whether journal or author self-citation, excluding abnormal cases like forced self-citation, self-citation is a scientific communication behavior based on the continuity and inheritance of knowledge production, reflecting knowledge relevance and content similarity between documents, just like citations by others.

4.2 Self-Citation as a Special Form of Knowledge Diffusion

Self-citation is a dialogue between past and present research, reflecting authors' cognitive and creative processes and representing a special form of knowledge diffusion through the authors themselves. R. H. Gálvez trained a topic discovery model to measure semantic similarity between self-cited and other-cited documents, finding significantly higher similarity in self-citations, indicating that author self-citation is indeed motivated by knowledge relevance rather than other factors [53]. Chinese scholar Liu Guiqin confirmed that self-cited documents have the highest average cosine similarity and correlation coefficient, with significant positive correlations between documents, while other-cited documents have lower textual similarity and correlation, showing that self-citation is primarily "content-driven" [86]. Self-citation helps readers grasp research progress

and academic trends, and through "source tracking" understand research origins and evolutionary trajectories, making it an effective mechanism for knowledge diffusion. Previous scholars focused too much on self-citation' s performance in scientific evaluation, always questioning its interference with citation indicators, while neglecting its positive effects in knowledge diffusion.

L. Zhou argued that other-citation may involve "hasty citation" without full understanding of others' work or "secondary citation" without reading original sources, resulting in low-quality citations that are not beneficial for studying knowledge diffusion. Authors are very familiar with their own prior work, making self-citation more accurate than other-citation [87]. Additionally, self-citation has better timeliness in knowledge diffusion [88]. R. Rousseau compared annual distribution curves of self-citation and other-citation frequencies, finding self-citation more novel and timely, with little likelihood of self-citation occurring after ten years [89]. When citing their own work, authors need not wait for long publication cycles or search, read, and compare massive literature, but can directly select from their most familiar knowledge base (including published and unpublished works), with some documents entering the citation system before formal publication. Self-citation greatly shortens citation delay, making it more reflective of emerging knowledge, viewpoints, and methods than other-citation when using citation relationships to examine scientific communication and knowledge diffusion patterns. W. Y. L. Lin et al., using environmental engineering literature, confirmed that self-cited documents are more timely than other-cited documents, with authors more likely to cite their recently published work, though the difference in age distribution between self-cited and other-cited documents is gradually narrowing, possibly due to emerging publishing models like online publication and preprints accelerating knowledge dissemination [89].

4.3 Self-Citation Reveals Academic Lineage

Scientific research is a continuous activity and a constantly renewing process, typically without dramatic changes [16]. A scholar publishes a series of outcomes at different career stages, with these sequentially published works showing directional consistency, content relevance, and conceptual inheritance, especially works published in the same or similar periods that are closely interconnected. Self-citation links these consistent, relevant, and inherited documents into a complete chain recording scholars' research footprints. Therefore, self-citation provides important support for examining a scholar' s research trajectory, a discipline' s knowledge structure, and its evolutionary path. When self-citation is minimal or zero during a period, it indicates the author has turned to new fields or established new collaborations; when self-citation in a discipline becomes more frequent while other-citation decreases, it suggests a new field is emerging [67]. Self-citation can detect changes in authors' careers and research fields, identify emerging research topics, and track changes in authors' research interests.

Self-citation networks are a special type of citation network formed by mu-

tual citations among papers published by an author and their collaborators, which can be used to characterize authors' research topics, observe changes in research trajectories, and identify key achievements [90]. I. Hellsten noted that author self-citation networks can better discover new research topics [91]. J. Y. Lee argued that author self-citation networks can successfully identify authors' core papers and leading achievements [92]. Wei Ruibin, using the School of Informatics, Computing, and Engineering at Indiana University as an example, constructed an internal self-citation network and used main path analysis to identify research topics and trace evolutionary history, suggesting the method could be extended to national or regional levels [93]. A. El-Aichouchi and P. Gorry, studying "sleeping beauty" documents by tumor angiogenesis pioneer J. Folkman, found that the "prince" was a self-cited document. Scientific development and knowledge accumulation are slow processes; for initially unrecognized "ahead-of-their-time" theories, self-citation can attract peer attention and accumulate more evidence to dispel doubts, ultimately awakening long-dormant theories—this is self-citation' s "self-awakening" function [94].

5 Reflections and Prospects

Self-citation research has spanned half a century, accompanied by ongoing questions and debates. While consensus on key issues remains elusive, it has laid a solid foundation for future research. The field has evolved from simple negation to cautious questioning, detailed verification, and recent exploration of self-citation' s new functions in examining scientific communication and knowledge diffusion. Research methods and approaches continue to innovate, with increasingly rigorous and rational attitudes. This paper reviews decades of research findings, mapping their main threads and evolutionary trajectory along a timeline, as shown in Figure 1 [Figure 1: see original paper].

5.1 Revealing Deep Patterns and Mechanisms Beyond Data Surface

Most previous research explained statistical correlations between self-citation indicators (such as frequency and rate) and citation metrics (such as JIF and h-index) from surface-level data, simply determining relevance and degree based on statistical data, while lacking deep analysis of underlying mechanisms and processes. For example, while scholars have observed that self-citation can increase citations by others, whether this is because self-citation increases document and author visibility or because self-cited documents are genuinely higher quality remains unexplained. While statistical data can directly prove self-citation' s impact on citation indicators, sample source and size limitations prevent conclusive findings and even exacerbate cognitive 分歧 and confusion, exemplified by debates over "whether self-citation should be excluded." This process is like "blind men touching an elephant" —each seems to have correct discoveries but only partial understanding that fails to grasp the essence or reflect the whole.

Future research should focus on what lies behind the data, summarizing patterns

and models from statistical data and quantitative analysis while explaining underlying causes. The focus should no longer be on whether self-citation affects citation indicators or whether excessive self-citation inflates citation data, but on how self-citation affects indicators and the mechanisms linking self-citation to citation metrics. Only by clarifying these issues can we understand patterns, grasp essence, and propose more effective solutions. This field does not lack empirical research or quantitative analysis, nor does it need larger samples or more disciplines for re-testing. What it urgently needs is theoretical support and basis, requiring scholars to trace the context and distill patterns from years of accumulated statistical data and observations, enabling us to abandon biases and misunderstandings about self-citation and understand it and its potential impacts more objectively and rationally. Only then can we open a new phase of self-citation research rather than remaining trapped in cycles of simple questioning and testing.

5.2 Examining Knowledge Structure from New Perspectives via Self-Citation Networks

The root of self-citation debates lies in different perspectives. From a scientific evaluation rigor perspective, self-citation indeed risks artificially inflating citation indicators and distorting evaluation results. From a scientific communication completeness perspective, self-citation is an indispensable phenomenon. The merits of self-citation depend on researchers' positions and viewpoints, with previous research mostly focusing on the former while neglecting the latter. In fact, self-citation is a special citation phenomenon and an effective mechanism of scientific communication that shoulders important responsibilities for academic inheritance and knowledge diffusion. Regardless of its positive or negative role in scientific evaluation, it does not affect self-citation' s positive efficacy in examining scientific communication and knowledge diffusion. In scientific communication, self-citation and other-citation have complementary functions. Science is a vast network woven by authors, documents, journals, and other academic entities, each analyzable for its relationships with others, making self-citation' s efficacy in examining knowledge diffusion promising.

In bibliometrics, citation analysis is the main method for revealing knowledge structure, including direct citation, bibliographic coupling, co-citation, and mutual citation, widely applied to examine knowledge structure but mostly based on other-citation. Self-citation analysis offers a new perspective and approach, with complex network analysis and visualization technologies promising new conclusions and discoveries. As mentioned earlier, research has confirmed that self-cited documents have greater semantic similarity than other-cited documents and that self-citation is more accurate and timely, providing useful groundwork for exploring self-citation' s new bibliometric functions in revealing knowledge structure and representing academic relationships. Future research in this area will use self-citation networks to trace authors' academic trajectories, examine career changes, reveal discipline knowledge structures and evolutionary patterns,

and predict emerging topics. We look forward to new discoveries and conclusions from self-citation analysis, though the feasibility, scientificity, and particularity of self-citation analysis in revealing knowledge structure require further exploration.

5.3 Identifying Inappropriate Self-Citation and Correcting its Effects

While we wish to view self-citation optimistically, we should remain cautious. Forced self-citation, excessive self-citation, and similar practices do exist. If ignored, they may lead to the spread and deterioration of inappropriate citation behavior, ultimately preventing self-citation from reflecting true scientific impact, threatening the order of citation-mediated scientific communication, and most severely, undermining academic ethics and damaging academic atmosphere [95]. Therefore, whether to ensure scientific evaluation accuracy, maintain academic communication order, or stop inappropriate citation and purify academic atmosphere, distinguishing legitimate from inappropriate citation and identifying and correcting the side effects of inappropriate citation in scientific evaluation are essential. While some studies have proposed solutions—such as setting self-citation thresholds and frequency limits, examining annual changes in self-citation rates, and calculating self-cited document similarity—these have not gained widespread acceptance or application, and their effectiveness and scientificity require testing.

Future research must strengthen this area: on one hand, using semantic models, machine learning, complex network analysis, big data analytics, and other technologies to automatically identify journals, authors, and articles with existing or suspected inappropriate self-citation from massive self-citation data; on the other hand, while strengthening academic self-discussion, we must explore how to establish supervision and constraint mechanisms for inappropriate citation behavior, including not only inappropriate self-citation but also citation clubs, forced citation, and gift citation, all of which should be jointly resisted and supervised by the academic community.

Self-citation has always been under ethical scrutiny, with negative comments predominating despite the lack of unified conclusions [96]. While self-citation carries manipulation risks, this does not mean it is "evil by nature"; often it simply "goes astray" in an imperfect research evaluation system. In the "publish or perish" era, citation-oriented research evaluation systems have created tight links between citations and academic status, career advancement, funding, and material rewards, improving scientific output efficiency while also bringing negative effects, with inappropriate self-citation being one of them [97]. Some scholars even argue that citation indicators cannot reflect research quality or scientific impact [98]. A. Racz and S. Markovic strongly criticized the use of impact factor indicators to evaluate journals, individuals, papers, and institutions, arguing that all inappropriate citation behavior (including inappropriate self-citation) ultimately stems from unreasonable policy design, and that "impact factor-only" evaluation methods should not only be questioned but completely

abolished [99]. No amount of debate and verification, even if finding feasible methods to identify inappropriate citation, can fundamentally solve the problem. In the long run, we should change the current evaluation system, weaken the role of citation indicators in research performance evaluation, and actively explore new evaluation indicators to fundamentally eliminate the breeding ground for inappropriate citation [100].

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Note: Figure translations are in progress. See original paper for figures.