

On the framing of patent citations and academic paper citations in reflecting knowledge linkage: A discussion of the discrepancy of their divergent value-orientations

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Abstract It has been widely recognized that academic paper citations will reflect scientific knowledge linkage. Patent citations are similar to academic paper citations in many aspects: Citation frequency distribution is often skewed; citation frequency varies from one subject field to another and authors'/inventors' preference for citing relevant literature is usually confined to their own native language. However, regardless of these seemingly similarities, the patent citation is unique and special. It is constructed by incorporating information providers from multiple sources, such as from examiners, inventors, attorneys and/or the public. It is driven by a value-orientation for the monopolization of market production under regulations of Patent Laws. It is also practiced under the sway of an industrial culture embedded with a notion of "creative destruction". In view of the contextual complexities of patent citations, simply applying the data criteria and citation behavior analysis of academic paper citations to that of patentbibliometrics for the purpose of reflecting knowledge linkage is both conceptually and technically illogical and unreasonable. This paper attempts to delve into the issue of the currently misconceived assertions and practice about "transplanting" the methodology of academic paper citations en masse indiscriminately into the practice of patent citations. It is hoped that such a study would yield improved result stemming from the practice of patent citations for reflecting knowledge linkage in the future.

Keywords Patent citation, Knowledge linkage, Patentbibliometric

Academic paper citations are conveying a sense of identification of an author's academic interest with other prior published researches in the similar subject fields. In addition, it provides a clue for tracing scientifically the knowledge linkage horizontally and vertically. Patent citation discussed in this article includes the aspects of previously granted patents and non-patent references cited by a patent.

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In recent years, many scholars^[1-4] have devoted much of energy to the analogue research on correlations between academic paper citations and patent citations. Some striking similarities between them have been found. Based on the premise of that finding, a number of scholars have suggested tracing technical knowledge linkage using the method for practicing patent citations. This article will explore and compare the similarities and differences between the criteria of academic paper citations and that of patent citations in order to reflect the unique ways of each for tracing knowledge linkage.

1 Similarities between academic paper citations and patent citations

Narin (1994)^[1] of CHI Co. first proposed the concept of patentbibliometrics on the basis of bibliometrics. Since then, many scholars around the world have been studying the similarities between academic paper citations and patent citations. There are three main streams of views about this issue as follows.

1.1 The similarity in citation frequency distribution

Brooks' "minus exponential model" shows an important rule of citation frequency distribution in academic papers. Narin (1998)^[5] comparatively counted the citation frequency of American patents in biotechnology area and the citation frequency in similar subject area as collected by SCI. He found the typical Pareto Distribution in both of them. The frequency of citations in these two subject fields resembled in minus exponential distribution and the former is much higher. He also found that only 10% of SCI papers and 12% of patents are cited more than twice. The peak time of being cited both appeared during the period from 2nd to 4th year. Jang, Lo & Chang (2009)^[6] studied the distribution of citation frequency by patents in flat-panel field in China's Taiwan. They found that the distribution curve fitted the minus exponential model well and the head and long tail were clear.

1.2 The similarity of varied citation frequency in different subject fields

One remarkable characteristic of academic paper citation is that citation frequency varies from one subject to another. As a result, there are significant subject differences among half-life of different subjects. According to bibliometrics research, high citation frequency accompanying short half-life occurred in chemical and metallurgy subject areas, whereas low citation frequency associated with long half-life occurred in geology and mathematics subject areas. Narin (1997)^[3] statistically analyzed citations of American patents and European patents. He also found that citation frequency varied from one industry to another. Most citation appeared in biopharmaceutical and chemical industry, followed by engineering. In contrast, low



citation frequency appeared in geological, spatial industries and hardly any citation could be found in mathematical or psychological technologies. Tijssen (2002)^[7] supplemented the list with more emerging industries that had high citation frequency, such as laser, semiconductor, fiber optics, mobile communications and medical imaging.

1.3 The similarity between authors and inventors in citing literature in their own native language

Language orientation is another important characteristic of academic paper citation. Jaffe & Trajtenberg (1999)^[8], Michel & Bettels (2001)^[4] and Hu (2009)^[9] conducted a series of surveys on patent citations in United States, Britain, France, Germany, Japan, Korea and other countries. They found that Japanese and Korean patent citations presented a picture of localized phenomenon. American patents and British patents also often cited each other's patents because of their use of a shared common language.

Chen & Hicks (2004)^[10] who after having summarized scholars' views in knowledge linkage researches, declaimed that patent citations were to become an important means for tracing knowledge linkage among technological innovations.

2 Academic paper citations and scientific linkage of knowledge

In scientific research environment, the author of an academic paper is the predominant citing behavior subject. Although a tiny fraction of academic paper citations may transmit a notion of opposing points of view or even harsh criticism, the main motives of such citations are^[11], on the whole, to credit to pioneer, give honor to literature, check data or method or parameters, provide background literature, etc.

An academic paper citation represents a researcher's specialized academic interest with those of his or her academic colleagues and predecessors. It builds an intellectual bond and heritage for an academic disciplinary area and also fosters the continuous growth and advancement of that particular subject field^[12]. Therefore, there is a prevailing view that academic paper citations will weave all the academic papers into a unified knowledge network through its unique function of knowledge linking. Citation network would be the ideal raw material type to map out the landscape of human knowledge.

3 Uncertain causational relationship between patent citations and technical knowledge linkage

"Does patent citation reflect technical knowledge linkage?" It is still a controversial issue. According to literatures [1] - [4], patent citations are in a way so similar to academic paper citations; they can automatically reflect technical knowledge



linkage. Nevertheless, the empirical studies by Jaffe, Trajtenberg & Fogarty (2000)^[13] have shown that patent citation is “noisy indicators”. In their survey, only 1/2 of the patent samples have actually had knowledge linkage with the literature cited by them. Criscuolo, Verspagen & Criscuolo (2008)^[14] statistically studied patents from European Patent Office, and claimed that only 20% of the patent citations reflected the knowledge linkage directly and another 16% of them did indirectly. Why did a fairly large number of patent citations not actually reflect knowledge linkage? We try to provide an answer in the following way.

Patent specification is both a kind of technical literature and more importantly, a kind of legal document. Patent Laws specified the various responsibilities in varying degrees for citing patents by primary subjects (including examiner, inventor/attorney, the public, etc). Different primary subjects with different citing motivations will cite different objects. Thus, different patent citations will reflect knowledge linkage in no small varying degrees.

3.1 Patent citation behavior of examiners and the resulting knowledge linkage

According to Section 131 of the United States Patent Law, Sections 90 to 92 of the European Patent Convention, Section 63 of the Patent Law of Japan, Section 38 of Implementation Guideline for the Patent Law of China, examiners should search and cite related prior patents or publications as a frame of reference to check a submitted patent application to see whether it is already in public knowledge domain or whether it is built directly from some public knowledge or otherwise obviously enlightened by them, and then relying on their findings to make a judgment about this patent application's patentability, including its novelty, creativity, and practicability. According to Section 112 of the United States Patent Law, Section 84 of the European Patent Convention, Sections 70 and 71 of the Patent Law of Japan, Section 21 of Implementation Guideline for the Patent Law of China, claims of a patent would be limited by the prior patent it cited. For instance, if patent B cites patent A, some claims of patent B would be subordinate to the related claims of patent A as a dependent claim.

Patent citation by examiners, using comparative documents for their patentability judgment, will directly reflect knowledge linkage between a patent and the literature it cited. The knowledge linkage discovered by Jaffe, Criscuolo and their colleagues might have been mainly derived from citations by examiners.

3.2 The uncertainty of knowledge linking functions of patent citations by inventors and/or attorneys

According to Section 1104 of the United States Patent Law and Chapter 6 of the European Patent Convention, applicant (the inventor or attorney) must cite the prior



art of the same subject matter to illustrate the state of the artifacts. Section 2257 of the United States Patent Law further specifies the citation format of patent specifications.

Nevertheless, Nanba, Anzen & Okumura (2008)^[15] found that citations by inventor/attorney in patent specifications always came with the following phrases, such as “all of the prior art ... existed problems...”, “however... these cannot”, “nevertheless... it has drawbacks...” and so on. For example, suppose that there is a patent about using gene technique to treat diabetes. He cites a lot of patents about using chemical compound to treat diabetes. The motive of giving these citations is simply to criticize the shortages of chemical compound, complicated process of manufacturing or high cost, and consequently to advocate its own gene technique in treating diabetes.

Tijssen (2001)^[16] found that most patents of electronic instruments in Holland cited literatures in clinical medicine field. The driving force for these citations was to point out problems in clinical practice, and then lead to the introduction of electronic medical devices (like CT scan device and B exceeds device) which can solve these problems.

The above-mentioned citations by inventors/attorney reflected neither the knowledge linkage between chemical compound and gene technique, nor the knowledge linkage between clinical medicine and electronic instruments.

In this context, citations by inventors/attorneys may express only negative attitude rather than giving recognition to the content that they cited. This kind of citations might be the main source of the “noise” found by Jaffe and his colleagues.

3.3 Patent citations by the public and thereof the unattainable knowledge linkage

According to Section 135 in the United States Patent Law, Section 700 in Manual of Patent Examining Procedure in the United States, Section 97 in the European Patent Convention, Sections 50 and 55 in the Patent Law of Japan, Section 38 in Implementation Guideline for the Patent Law of China, during the period of public consultation before a patent is issued, the public could raise objections and put forward the proof by citing relevant prior publications.

However, since a patent application has already been approved and the patent specifications and its claims have been issued, the objections to a patent during its examination process have been unable to overturn its patentability or its claims. That is to say, those citations provided by the public as defense for their objections are ineffective or are not relevant enough to the patent granting. The reason why these contradictory citations from the public are listed in patent granting specification anyway is to archive them for resolving possible disputes about this patent in the



future. In light of this, this kind of citation might be regarded as another source of “noise”.

4 Reasons for discrepancies in knowledge linking performance between academic paper citations and patent citations

4.1 From the viewpoint of social dynamics

Academic papers as achievements of scientific research, offer a realistic description about the real situation of the world through answering such questions as “what it is” and/or “why it is.” Truth-seeking is their social dynamics. However, patents as achievements of technological innovations, offer new products and improve life qualities through answering such questions as “what to do about it” or “how to do it.” Goodness-seeking is their social dynamics.

The behavior of citing academic papers is in reality to learn, to utilize and to inherit what have been accomplished by pioneers. In other words, academic paper citation behavior is the transmission of valuable lessons learned by the forerunners in a specific field to pass them down to the newcomers in this particular subject field. It is an exhibition of how the development of human civilization is being accumulated as well as how the spirit and mechanism of knowledge sharing for public good and the ethos of science communism is being translated into the practical practice of academic paper citations. Academic paper citations provide linkage of all relevant scientific knowledge units organically.

In contrast, the essence of applying a patent right is to strive towards market production monopoly. The patent holders are reluctant to be emulated or copied by others. Patent Law stipulates that an application for new patents should not be based on some prior art directly or be enlightened obviously by it. As such being the case, patent applicants (inventors /attorneys) are intuitively to avoid getting into existing areas covered by the protection of Patent Law in their patent citation behavior. Otherwise, their patent application would be rejected on the basis of their violation of patent laws. As Garfield (1985)^[17] once pointed out, “an inventor will try to cite other different or dissimilar prior art to prove the novelty and priority...” The pursuit of monopolies and the strategies so devised by inventors and attorneys alike for passing through the patent examination have essentially shaped patent citation behavior. This will greatly limit the level of knowledge linkage function of patent citations.

4.2 From the viewpoint of Patent Law

Academic paper citations are not subjected to the legal restrictions of any law. Although there are certain rules about citing and/or referencing academic papers in



Copyright Law, they are confined to the area of rendering judgment about plagiarism, and have no effect on reflecting the linkages among knowledge units.

Patent citation writing is specified by Patent Law and its legal functions are illustrated formally. In different countries, the requirements about patent citation are quite different. In the United State Patent and Trademark Office, inventors are required to cite related prior art as much as possible. In the European Patent Office, only necessary citations are required. In the United Kingdom Patent Office, its emphasis is on the omission of unnecessary citations. In the German Patent Office, it focuses only on the direct relationship among citations. But, some national patent agencies, such as the Japan Patent Office and the State Intellectual Property Office of China, have not prescribed detailed regulations on patent citations. These laws and regulations mentioned above may affect the knowledge linkage function of patent citations in varying degrees.

4.3 From the viewpoint of economy

For some macro-economists, academic paper citation is regarded as objective data sources to calculate knowledge stock and knowledge flow of a society. In the consistent progress of social scientific knowledge accumulation, the academic paper citation is a clue throughout the story, which records the inherited knowledge from ancestry to posterities. It reflects also knowledge flow from one domain to another.

For some micro-economists, patent citation serves as a representative device of “creative destruction.” The concept of “creative destruction” brought forth by Schumpeter, means that enterprises rely on better products to beat their rivals. They win profits through replacing the old products and technologies by the new ones. This process will be in an infinite loop. Caballero & Jaffe (1993)^[18] described the creative destruction for using patent citation function:

$$a^*(t, s) \equiv \frac{C_{t,s}}{S_t P_s},$$

$C_{t,s}$ refers to the citations received by the patents at time point of t from the patents at time point of s , S_t is the number of sample patents at the time-point t , P_s is the number of sample patents at the time-point s . $a^*(t, s)$ represents the destruction to the patents at time point of t by the patents at time point of s .

In Bertran’s view (2004)^[19], patent citation is the by-product of market competition among enterprises. If a new patent i cited a prior patent j , some market share was stolen by patent i from patent j . The market steal mechanism could be indicated by the following function:



$$\mu(i, j) = \frac{\mu(i)}{m_i},$$

in which m_i denotes the total citation by patent i , $\mu(i)$ denotes the whole market share occupied by patent i , $\mu(i, j)$ represents the market share stolen by patent i from patent j .

Furthermore, the essence of academic paper citation is “to win benefits together collectively” by sharing human wisdom in this multi-win game. The late comers inherit and pass on knowledge through reading, citing and disseminating documents and citations. Meanwhile, the forerunners gain academic reputation without losing any of their own material and intellectual assets. In this way, academic paper citation reflect knowledge linkage in a natural and steadfast manner. Conversely, the essence of patent citation is “to compete for benefits monopoly” by fighting a merciless market battle. In this zero-sum game, the late comers steal market share through patent citations, which unavoidably result in forerunners’ loss of their rightfully gained market share/profit. In this way, patent citation can only represent “creative destruction” rather than the purported aim of knowledge linkage.

5 Future works

The general similarities in methodological analysis between academic paper citations and patent citations may suggest that there are some valid reasons for transplanting the methodology of academic paper citation analysis to that of patentbibliometrics. However, the divergent objectives and functionalities in terms of knowledge linkage between them are far apart. It is irrational to superimpose the citation model for academic papers on the construction of a similar one for the patent citation without first to make a comprehensive study about the contextual complexities of the patent citation. Along this line of thinking, our future work would include: 1) to make an empirical study on patent citation by examiners, inventors/ attorneys and the public respectively, 2) to distinguish and differentiate various citing motivations, 3) to figure out the most scientific way for reflecting knowledge linkage, and 4) to develop a unified model by taking into consideration of the elements of similarities and differences reflected in both academic paper citation analysis and in patent citation analysis so as to make knowledge linkage more scientifically satisfactory to all parties concerned.

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