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The impact of collaboration and knowledge networks on citations

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ABSTRACT

Research papers not only involve author collaboration networks but also relate to knowledge networks. Previous research claims that a paper's citations are related to the node attributes of its authors in collaboration networks. We further propose that a paper's citations can also be affected by the node attributes of its knowledge elements in knowledge networks. In this study, we develop a new method to construct the knowledge network using article keywords. Further, we explore the antecedents of paper citations from both the collaboration and knowledge network perspectives. Using wind energy paper data (16,351 records) collected from WoS (Web of Science) and JCR (Journal Citation Reports) database, we construct two distinct networks and empirically examine the hypotheses of the relationships between node attributes of two networks and the paper's citations, which fill the gap in prior studies and will inspire related studies. We have the following key findings: in the collaboration network, the structural holes of authors have positive but non-significant effects on the paper's citations, while the authors' centrality has inverted U effects on the paper's citations; in the knowledge network, the structural holes of knowledge elements are positively related to the paper's citations, and the knowledge elements centrality has an inverted U relationship with the paper's citations.

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1. Introduction

The research impact of a paper is the extent to which it is useful to other researchers (Rousseau, García-Zorita, & Sanz-Casado, 2013; Garfield, 1979; Leydesdorff and Bornmann, 2011). To assess the research impact of papers, forward citations (named citations below) count is usually used (Garfield, 1972; Leydesdorff and Opthof, 2010). Citations received by a paper means the number of times its content (method, ideas, and so on) is formally used in subsequent papers (Lozano, Larivière, & Gingras, 2012; Uzzi, Mukherjee, Stringer, & Jones, 2013). Previous research has found a large variance of citations received by papers, as some papers are highly cited thousands of times, while nearly 20% papers have never been cited at all (Mingers and Burrell, 2006; Redner, 1998). This may raise the following question: What factors affect paper citations? To answer the question, our research will focus on the publication level rather than the researcher or institute level.

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There are many reasons why papers are cited by researchers. Previous research combined different frameworks, views, and methods to study the influence factors of publication citations. For instance, [Bornmann and Daniel \(2008\)](#) claimed that researchers are motivated to cite a paper not only to acknowledge academic importance of this paper, but also for some non-academic reasons. [Tahamtan, Safipour Afshar, and Ahamdzadeh \(2016\)](#) summarized all the factors related to the number of paper citations: paper related factors (e.g. abstract), journal related factors (e.g. impact factor) and authors related factors (e.g. author number). In addition, some scholars began to realize the importance of social-based networks in influencing paper citations ([Abbasi and Jaafari, 2013](#)).

Collaboration network, as a typical social-based network in research, has received much attention ([McFadyen and Cannella, 2004](#); [Guan, Zuo, Chen, & Yam, 2016](#)). The positions of authors in the collaboration network play important roles in taking advantage of diverse resources, thereby significantly influencing their publication citations ([Abbasi, Hossain, & Leydesdorff, 2012](#); [Newman, 2004](#); [Li, Liao, & Yen, 2013](#)). For example, [Li et al. \(2013\)](#) examined the positive effects of authors' centrality on their citation count. [Abbasi, Altmann, and Hossain \(2011\)](#) found that scholars' degree centrality and structural holes positively affect the citation-based performance. Based on previous research, we argue that the citation of a paper is affected by its authors in the collaboration network. Recently, [Abbasi and Jaafari \(2013\)](#) examined the positive effects of the geographically diverse collaboration on citations at the publication level.

However, we argue that a paper involves not only the collaboration network (social-based) but also the knowledge network (knowledge-based). A knowledge network is comprised of combinations between components or elements of scientific or technological knowledge. Knowledge elements indicate the dimensions and categories of a knowledge area. For instance, patents are usually categorized into several classes to express their technological features ([Guan and Liu, 2016](#)). Thus, a patent's technological classes have been widely accepted as valid proxies for knowledge elements ([Carnabuci & Operti, 2013](#)). Similarly, scientific papers usually include multiple keywords to indicate their knowledge elements ([Muñoz-Leiva, Viedma-del-Jesús, Sánchez-Fernández, & López-Herrera, 2012](#); [Cobo, López-Herrera, Herrera-Viedma, & Herrera, 2011](#); [Su and Lee, 2010](#)). According to the extant bibliometric literature, publication keywords can be considered as knowledge elements. For example, related studies used keywords in depicting knowledge structure maps ([Su and Lee, 2010](#); [Assefa and Rorissa, 2013](#); [Yang, Han, Wolfram, & Zhao, 2016](#)), knowledge hotspot detections ([Chen, 2006](#)) and research trend analyses ([Xie, Zhang, & Ho, 2008](#)). Following these previous approaches, in this study, we use keywords of a paper to indicate its knowledge elements. We then apply a co-keyword network to represent the knowledge network. Knowledge elements are linked through their co-occurrence in previous publications. Over time, these elements are interwoven into a network that records their combinatorial or co-occurrence histories. Knowledge elements can be replenished in use, combined or recombined in the processes of generating innovation ([Garud & Kumaraswamy, 2005](#)). In such innovative processes, knowledge elements form associative or combinational relationships with each other, leading to the formation and development of knowledge networks. In this study, we propose that the structural attributes of knowledge elements in knowledge networks will influence the knowledge elements' combination opportunities and efficiency. For example, a central knowledge element is more likely to be searched and novelly combined with other elements because it has more contents and experiences of element couplings. As such, the node attributes of knowledge elements may affect the citations of the paper involving these elements. We want to fill the gap left by the lack of studies that have built the knowledge network and investigated the influence of this network on paper citations.

Our research is at the paper level rather than researcher or institute level, as we consider the average of authors or keywords' measures for each publication. This study focuses on how the network attributes of authors and knowledge elements influence a publication's citation. This study has several contributions: (1) we develop a new method to construct the knowledge network using article keywords, which fill the gap left by prior studies and will inspire further related studies; (2) this study highlights the importance of knowledge and collaboration networks in citations. Specifically, we firstly consider node attributes (e.g., degree centrality and structural holes) of authors in collaboration networks and knowledge elements in knowledge networks as influence factors of paper citations; (3) we focus on the paper level citations. Most studies aggregated citations to the author level, organizational level or journal level. We argue that the same author sometimes has distinct citations in different papers, thus the fine-grained analysis of a paper's citations is needed.

Our empirical analysis focuses on wind energy research. Wind energy research has been experiencing unprecedented growth and is now worldwide booming. Moreover, as technologies develop, the wind energy field involves more and more researchers and yields a wealth of distinct knowledge elements. Thus, this field is a typical example of a high velocity field with easily observed collaboration and knowledge networks. Based on the retrieval strategy of wind energy, we collected a sample of 16,351 papers published from 2002 to 2015.

An objective of our research is to explore how collaboration and knowledge networks affect a paper's citations. We applied ordinary least squares (OLS) model with robust standard errors to test the above-mentioned relationships. The remainder of our paper is arranged as follows: Section 2 introduces our hypotheses. Section 3 describes our data collection and variable measurement, followed by the descriptions of wind energy research, descriptions of networks and empirical tests in Section 4. Conclusions are given in Section 5.

2. Theory and hypotheses

Different node attributes indicate different chances of accessing new information that is important in creating high quality research. In this study, we mainly study two node attributes—degree centrality and structural holes—in two kinds of

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