Journal of Informetrics 9 (2015) 135–144

Contents lists available at ScienceDirect

Journal of Informetrics

journal homepage: www.elsevier.com/locate/joi

The relationship between the research performance of scientists and their position in co-authorship networks in three fields

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ARTICLE INFO

Article history:
Received 12 August 2014
Received in revised form 6 November 2014
Accepted 3 December 2014
Available online 26 December 2014

Keywords:
Research performance
Collaboration
Social network analysis
Co-authorship
G-index
Poisson regression model

ABSTRACT

Research networks play a crucial role in the production of new knowledge since collaboration contributes to determine the cognitive and social structure of scientific fields and has a positive influence on research. This paper analyses the structure of co-authorship networks in three different fields (Nanoscience, Pharmacology and Statistics) in Spain over a three-year period (2006–2008) and explores the relationship between the research performance of scientists and their position in co-authorship networks. A denser co-authorship network is found in the two experimental fields than in Statistics, where the network is of a less connected and more fragmented nature. Using the g-index as a proxy for individual research performance, a Poisson regression model is used to explore how performance is related to different co-authorship network measures and to disclose interfield differences. The number of co-authors (degree centrality) and the strength of links show a positive relationship with the g-index in the three fields. Local cohesion presents a negative relationship with the g-index in the two experimental fields, where open networks and the diversity of co-authors seem to be beneficial. No clear advantages from intermediary positions (high betweenness) or from being linked to well-connected authors (high eigenvector) can be inferred from this analysis. In terms of g-index, the benefits derived by authors from their position in co-authorship networks are larger in the two experimental fields than in the theoretical one.

1. Introduction

Science is increasingly becoming a collaborative endeavour. Collaboration allows scientists to share knowledge, expertise and techniques, expedites the research process, and increases visibility (Katz & Martin, 1997; Sonnenwald, 2007). Under the assumption of the importance and benefits of collaboration for the advancement of science, scientific collaboration is encouraged by policy makers and the collaboration process is the subject of many academic studies.

From a bibliometric standpoint, collaboration is usually analysed through co-authorship in scientific publications. This indicator presents several limitations, since all co-authorships are sometimes not based on collaborative contributions (e.g. honorary authorship) and not all authors who collaborate become co-authors (Laudel, 2002). However, a positive correlation

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http://dx.doi.org/10.1016/j.joi.2014.12.001
1751-1577/

between collaboration and co-authorship has been described in the literature and this indicator has proved useful to study different aspects of collaboration in science (see for example, Glänzel & Schubert, 2004). Accordingly, co-authorship is used as a measure of scientific collaboration in this paper, although we should have in mind its limitations.

Different indicators have been introduced to quantify collaboration in research papers (see for example, Egghe, 1991; Glänzel & Schubert, 2004; Vinkler, 2010) and extensive literature has been devoted to explore collaboration patterns (Bordons & Gómez, 2000) and the influence of collaboration on the productivity of scientists and on the impact of research (Abramo, D'Angelo, & Di Costa, 2009; Bordons, Aparicio, & Costas, 2013; Glänzel, 2001; Lee & Bozeman, 2005). In most recent years, the application of social network analysis to study co-authorship relations has emerged as an interesting approach, since it allows us to visualise and investigate social structures and relations (see for example, Abbasi, Altmann, & Hossain, 2011; Abbasi, Chung, & Hossain, 2012; Jansen, von Görtz, & Heidler, 2010; Li-Chun, Kretschmer, Hanneman, & Ze-Yuan, 2006; Newman, 2001; Otte & Rousseau, 2002). Studies of co-authorship networks may focus on the global structure of networks (macro-perspective) (see for example, Newman, 2001), on the study of subsets (clusters or components) formed within the network (meso-perspective) (He, Ding, & Ni, 2011) or on the individual scientists included in the network's membership (micro-perspective) (for example, Hou, Kretschmer, & Liu, 2008).

Different studies suggest that research networks play a crucial role in the production of new knowledge. The basic idea is that "the position of a node in a network determines in part the opportunities and constraints that it encounters, and in this way plays an important role in a node's outcomes" (Borgatti, Mehra, Brass, & Labianca, 2009). In other words, this means that the position of a scientist in the co-authorship network may have an influence on his/her research performance. This is clearly related to the notion of "social capital", defined as the benefits that actors derive from their social relationships (Coleman, 1988), which may contribute to knowledge creation and to human capital development (Liao, 2011). Three different dimensions of social capital have been described (Nahapiet & Ghoshal, 1998), namely, cognitive capital, relational capital, and structural capital. The latter is the main subject-matter of this study and it can be defined as the value or advantage accrued by an individual or group arising from the structure of social relationships.

There is no consensus on which type of network structure performs best. According to Coleman (1988), densely embedded closed networks are advantageous because they foster the building of mutual confidence and partners bind themselves to one another through reciprocal obligations and expectations ("closure argument"). On the other hand, an alternative view considers that social structural advantages derive from the brokerage opportunities created by an open social structure (Burt, 1992, 2004), since it fosters the flow of knowledge between heterogeneous actors and reduces redundant contacts. From this perspective, separate groups control different information and resources, and individuals who bring together people from the different groups act as "brokers" that bridge the existing gaps or "structural holes"[1] between groups ("structural hole argument"). Interestingly, these two notions of social capital are not necessarily contradictory, since different network structures may generate social capital depending on the purpose of the network and the members involved (Ahuja, 2000; Klenk, Hickey, & MacLellan, 2010).

The relationship between the position of authors in collaboration networks and their performance, as measured by the number of publications, the number of citations and/or the h-index or the g-index, as the case may be, has been previously analysed in the literature. A positive correlation between different centrality measures and citation counts has been described in the fields of information systems (Liao, 2011) and library and information science (Yan & Ding, 2009), while centrality measures showed a positive correlation with scientific output in scientometrics (Hou et al., 2008); these results suggesting that researchers with a higher number of collaborators (high degree) or those who are close to all others in the network (high closeness) are likely to obtain better performance results. Moreover, the influence of the strength of the ties among authors has attracted considerable attention in a number of studies. Scholars who have strong ties (repeated co-authorships) to co-authors earned better research performance results than those with weak ties (single co-authorships with many different authors) in a study on information science (Abbasi et al., 2011). In this study, having an efficient network, with a low rate of redundant contacts, enhanced research performance probably because redundant contacts are less frequently associated with groundbreaking initiatives since they do not provide access to new information. Conversely, establishing connections with researchers in new and diverse teams, bridging structural holes, appeared to be positive for research performance. A positive effect of structural holes on a researcher's performance, as measured by citation scores and individual creativity, was described also in a study in nanoscience (Heinze & Bauer, 2007), while the development of closed social networks with strong ties was positive in other studies on the biotechnology (Walker, Kogut, & Shan, 1997) and pharmaceutical industries (Guler & Nerkar, 2012). As mentioned above, the effect of structural holes on performance may vary depending on the context and the field. In this sense, Ahuja (2000) suggests that closed networks are beneficial when strong collaboration is required, while structural holes are likely to be more advantageous when access to diverse information is essential. On the other hand, the positive effect of structural holes may be higher in new fields (such as nanoscience) where brokerage positions become particularly significant because diverse knowledge and ideas are essential for the development of the field.

The patterns and consequences of network structures on scientific or innovative results have been studied in the literature at different levels of analysis, which range from individual scientists (Hou et al., 2008; Klenk et al., 2010; Li-Chun et al., 2006) or teams (Reagans & Zuckerman, 2001), to higher organisational units such as firms (Ahuja, 2000; Guler & Nerkar, 2012).

[1] A structural hole is the absence of ties among a pair of nodes in the ego network (Burt, 1992). The ego is the individual, team or organisational unit under analysis.