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Periphery authors, network embeddedness, and research impact: The case of Chinese inland scholars

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Abstract: Based on the social capital theory, this article takes the Chinese inland scholars' co-authorship network in the field of information science as the case, and investigates the influence of periphery authors' network embeddedness on research impact by applying Poisson regression model. The empirical results indicate that: (1) Degree centrality positively affect the net citations, (2) an inverted U-shaped relationship exists between the degree centrality and the net citations, which confirms the existence of the optimal collaboration size, and (3) structural hole positively affect the net citations.

Key words: Periphery authors; Network embeddedness; Research impact; Co-authorship network; Chinese inland scholars

JEL Class： M19

I. Introduction

In recent years, scientific collaborations among scholars have become a popular phenomenon. Extensive studies indicate that collaboration is beneficial for scholars, which may not only expand research areas, but also can provide complementary equipments and skills. In addition, scientific collaboration can make the best use of time and avoid competition. Regarding the impact of scientific collaboration on research output, Olmeda et al.(2009) investigate the scientific collaborations in Spain universities with social network analysis, and find that collaborations among Spain university is characterized by geographical imbalance. Abbasi et al.(2007) comparing three measures in social network analysis, which include degree centrality, betweenness centrality, and closeness centrality, and confirms the mediating role of betweenness for finding new partners. As for network embeddedness, Kim(2014) investigate the roles of structural embeddedness and relational embeddedness on supplier performance, and find that structural embeddedness may improve the operational performance, but cannot improve the financial performance. Packard (2015) investigate the impact of positional embeddedness and structural embeddedness on the success of actors, and find that positional embeddedness is more valuable for actors and structural embeddedness is more important for entire staff.

Although extant studies provides important perspectives for understanding the relationship between scientific collaboration and research output, most studies still focus on the impact of structural characteristics of collaboration on research output. In addition, studies on network embeddedness are also focusing on business areas. Therefore, there is still limited understanding on the impact of network embeddedness on research output.

This article tries to fill the gap by using social capital theory and investigate the impact of network embeddedness on research output. Specifically, this paper takes the Chinese inland scholars' co-authorship network in the field of information science as the case, and investigates the impact of peripheral authors' network embeddedness on research impact by applying Poisson regression model.

II. Theoretical background

Social capital refers to the characteristics of social organization, such as trust and rules, which may improve social efficiency by coordination between actors (Burt, 2000). Social capital is a symbol of advantage. Society can be seen as a market, in which actors exchange goods and ideas for individual benefits. The returns depend on the ability of individual actors. Social capital is a complementary to human capital. Embeddedness in the social network is an asset, which may provide the specific actor with better channels for accessing information (Burt, 2000).

Social capital includes inter-personal relationship and those resources embedded in the relationships (McFadyen, 2004). An actor may access and employ the resources embedded in the relationships through interaction. Embeddedness is decisive for an actor to access social resources. In extant literature, two theories co-exist. One form of theory argue that closure in the network is beneficial, which may provide actors with mutual trust and efficient coordination. Other form of theory argue that open network involves large amount of structural holes, which may provide bridges for connecting isolated groups and accessing new information and resources(Gonzalez,2013). However, the above two theory are not conflict in essence. Burt(2000) argue that structural hole is a form of social capital, which may not imply that closure in the network is not a form of social capital. An actor occupy the structural hole may reap benefits. However, the process need trust, which may be guaranteed by closure in the network. He point out that closure is a form of social capital when trust is needed for establishing collaboration. In reality, social capital is the product of out-group brokerage and in-group trust in closure network.

Extant literature emphasize the impact of different dimensions of social capital on firm performance, which focus on structural capital or relational capital, with Moran(2005) as an exception. We discuss the impact of relational embeddedness and structural embeddedness on research output.

2.1 Relational embeddedness

Relational embeddedness refers to the breadth and depth of inter-personal relationships among scholars (Gonzalez,2013), which is based on the dyadic relationships between two actors. Relational embeddedness can be measured on three aspects. First, relational embeddedness can be measured by direct ties, which indicate the intensity of interaction. Relational embeddedness refers to the ties between two actors of agencies, which may be regarded as the social cohesion and inter-personal relationships. In addition, relational embeddedness can be seen as an asset, including trust, reciprocity and obligation, which are created by continued communication and coordination. Besides, the relational embeddedness can be seen as the intensity or quality of relationships (Kim, 2013)

As for the impact of relational embeddedness on firm performance, Tiwana et al.(2007) argue that higher degree of relational embeddedness may facilitate the close collaboration, which may contribute to access tacit knowledge and specific skills. Gulati et al.(2011) repeated collaborations may benefit of knowledge accumulation that technology and experience.

2.2 Structural embeddedness

Structural embeddedness refers to the patterns of connectedness among agents, including who they can access and how the relationship is created(Gonzalez,2013). The structural embeddedness is created in triadic or more complex relationships, involving more dyadic relationships (Kim,2013). Open network may bridge different isolated groups and access new information, which may contribute to performance improvement (Gonzalez,2013). In closely connected networks, agents trust each other and coordinate more often, which bring good results.

As for network embeddedness, Kim(2013) investigate the roles of structural embeddedness and relational embeddedness on supplier performance, and find that structural embeddedness may improve the operational performance, but cannot improve the financial performance. Krause (2016) finds that structural embeddedness may exert significant impact on the quality and flexibility of supplier firms.

III. Research Design

3.1 Date collection

The paper chooses articles published by Chinese inland scholars in Scientometrics as the data source, Using the advanced search option in Web of Science, the search tactics are as follows: "SO(journal's name)" and "AD" (author's address) for joint retrieval, such as "SO = Scientometrics Quarterly AND AD = People R China or China". A total of 469 articles were retrieved. Solo-authored articles and articles published by Chinese Hong Kong, Chinese Macao and Chinese Taiwan are deleted from the results, which lead to 447 articles as the final analysis object.

Based on the search results, the bibliographic information is collected, including the title, the name of author(s), affiliations and year of publication. We define the peripheral authors as those who are less influential and less important for the scientific development. In this article, we measure the peripheral authors based on the number of publications, i.e. authors with less than five publications are peripheral authors

3.2 Variables

We use net citations as the measure of research output。First, citation is an important measure for academic visibility and academic impact, which is widely used in assessing publications and journals. Second, because self-citation may exaggerate the research impact, we use net citations as the measure of research impact.

Relational embeddedness reflects the intensity of collaborations among scholars. The weak tie is beneficial for accessing heterogeneous knowledge, while strong tie is beneficial for the transfer of tacit knowledge. We measure relational embeddedness with two indicators: degree centrality and average tie strength.

Degree centrality refers to the direct ties which the focal actor connects with other agents. Such direct ties may contribute to resource exchange and integration, access new knowledge and experience, and improve the focal authors' problem-solving ability.

Strength of ties draws on a different way of accounting for these co-authorships, which is measured by all the collaborations of the focal author divided by the number of co-authors. As stated before, research collaboration could be beneficial, but this cooperation also entails various costs. For example, costs of finding the right partner, costs of organizing and distributing team work, costs of developing a shared understanding, trust, reciprocity and the transfer of high quality information and tacit knowledge, among other costs. For the above reasons, an individual scholar is inclined to cooperate with previously collaborated partners.

Structural embeddedness focuses on the position of the focal actors and how these actors establish connections. Densely connected networks provide actors with the access to resources, and reduce the potential opportunism. Embedded in loosely connected networks, actors may obtain heterogeneous resources to reduce information redundancy. We use structural hole and clustering coefficient to measure structural embeddedness (Burt, 2000; Kim,2013).

Structural hole refers to the non- redundant ties between two actors in social network. Burt(2000) argue that structural hole may provide actors with the benefits of information access and control, and therefore provide competitive advantage than other actors. Constraint is often used to measure structural hole. When the degree of constraint is higher, the structural hole is lower, which means the network is more closely connected.

Clustering coefficient means the degree of cluster of the focal actor with other adjacent actors, which is also used to measure structural hole. In network, if node k is also connected to node i and j, then node k, i, j is constructed as a inter-connected network. If the probability of the node k connected to adjacent nodes is higher, the clustering coefficient of node j is higher, which means the local network is densely connected. Otherwise, the clustering coefficient of node j is lower, which means the local network is loosely connected.

Because Beijing and Shanghai are two major areas which have are crowded with more universities. "211" universities are also provided with more funds than other universities. We use two variables to control the influence of geographical differences. If the focal author's affiliation is located in Beijing or Shanghai, the value is 1, otherwise 0. If the focal author's affiliation is "211" university, the value is 1, otherwise 0.

3.3 Methodology

The article uses social network analysis and Poisson regression model. For the measures on relational embeddedness and structural embeddedness, the co-occurrence matrix is constructed using Bibexcel. Ucinet is used to obtain the individual author's degree centrality, strength of ties, structural hole, and clustering co-efficient. The net citations are obtained through Web of Science. Control variables are obtained by the author's affiliations.

Because the dependent variable is non-negative, a count model is usually used. We compared the results of Poisson regression model and negative binomial model, and the results indicate that Poisson regression model is better than negative binomial model. Therefore, we use Poisson regression model to estimate the co-efficient.

IV. Empirical results

4.1 Descriptive statistics and correlation matrix of variables

Table 1 shows the Descriptive statistics. From Table 1, we can see that the average net citations of each author are above 11. The degree centrality is 3.98, which means each author have an average of 4 co-authors. The mean value of university is 0.74, which means that over half of the authors are working at "211" universities. Before using Poisson regression model, the multi-collinearity is checked with VIF, which is also shown in Table 1. The VIF values of all variables are less than the threshold value of 10, indicating the problem of multi- collinearity is not serious.

TABLE 1 Descriptive statistics

	Min	Max	Mean	Standard variance	VIF
Degree centrality	1	36	3.98	3.086	4.967
Strength of ties	1	4	1.07225	0.263178	1.652
Structural hole	0.209	1.724	0.87386	0.265331	4.329
Clustering coefficient	0	6.4	1.11965	0.927238	1.892
Area	0	1	0.4	0.491	1.007
University	0	1	0.74	0.439	1.016
Net citations	0	142	11.33	16.705	

Table 2 shows the correlation matrix between variables. From Table 2, we can see that net citations are positively correlated with degree centrality and Area. Besides, net citations are positively correlated with the strength of ties, indicating that an individual author is inclined to cooperate with previously collaborated partners.

TABLE 2 Correlation matrix

	Degree centrality	Strength of ties	Structural hole	Clustering coefficient	Area	University
Degree centrality	1					
Strength of ties	0.461***	1				
Structural hole	-0.702***	-0.055	1			
Clustering coefficient	0.197***	0.177***	0.309***	1		
Area	0.009	0.047	0.042	0.015	1	
University	-0.096**	-0.034	0.075	-0.072	-0.021	1
Net citations	0.185***	0.111*	-0.077	0.003	0.162***	0.001

***Significant at 0.01 level (two sides).

** Significant at 0.05 level (two sides).

4.2 Results of network Regressions

In order to investigate the impact of relational embeddedness and structural embeddedness on research output, we construct a Poisson regression model with net citations as the dependent variable. The Poisson regression results are shown in Table 3. From Table 3, we can see that the model has a relatively good of fitness.

Degree centrality has a significantly positive impact on net citations (β=0.252, p=0.0000), indicating that when the degree centrality is higher, the net citation of an individual author is also higher. When a focal author cooperate with more partners, which may bring benefits to the focal author by providing more information and resources, which in turn may improves the research quality.

The square of degree centrality has a significantly negative impact on net citations (β=-0.004, p=0.0000), indicating that degree centrality has an inverted impact on research quality. The results shows that there exist optimal collaboration size when a focal author seeks partners, which is consistent with the findings by Mcfadyen(2004). The results implies that although more direct ties means more information and resources, but more time are needed to maintain these relationship, which also may lower the research quality.

	β coefficient	Z statistics	sig.
Degree centrality	0.252***	16.396	0.0000
Degree centrality× Degree centrality	-0.004***	-11.08	0.0000
Strength of ties	-0.102	-1.906	0.0566
Structural hole	1.542***	11.868	0.0000
Clustering coefficient	-0.467***	-11.136	0.0000
Clustering coefficient ×Clustering coefficient	0.045***	6.025	0.0000
Area	0.460***	16.71	0.4298
University	0.025	0.789	0.0000
R-squared		0.119153	
LR statistic		774.58	
Prob(LR statistic)		0.0000	

Note：*** p＜0.01

TABLE 3 Poisson regression results

The strength of ties has a significantly negative impact on net citations (β=-0.102, p=0.0566), indicating that repeated collaborations among peripheral authors may have a negative impact on net citations. The reason may be that repeated collaborations among authors may produce information redundancy, therefore provide few new information that can be used in publications.

Structural hole has a significantly positive impact on net citations (β=1.542, p=0.0000), indicating that the higher degree of structural hole may provide the focal author with mutual trust and reduce opportunism, which may be beneficial for increasing research quality.

Clustering coefficient has a significantly positive impact on net citations (β=1.542, p=0.0000), indicating that the higher the clustering coefficient is, the higher the research quality will be. The results imply that an open network may reduce the redundancy in the network, and obtain heterogeous information, which are needed in improving research quality.

The square of clustering coefficient has a significantly positive impact on net citations (β=0.460, p=0.0000), indicating that moderate embeddedness has a significant impact on research quality. The closure and stability of network is beneficial not only for members to share tacit knowledge, but also may transfer opportunistic behavior of members, which may strengthen mutual trust and promote collaboration.

V. Conclusion

Based on the social capital theory, this article takes the Chinese inland scholars' co-authorship network in the field of information science as the case, and investigates the influence of peripheral authors' network embeddedness on research impact by applying Poisson regression model. The empirical results indicate that, (1) degree centrality positively affect the net citations, (2) an inverted U-shaped relationship exists between the degree centrality and the net citations, which confirms the existence of the optimal collaboration size, and (3) structural hole positively affect the net citations.

There are still some limitations with this study. First, co-authorship is only one form of scientific collaboration. Co-authored publication may not reflect the real collaborations. Scholars may cooperate in other forms, which may or may not involve implicit product. Future studies should use questionnaire to investigate the real collaborations among scholars(Gonzalez,2013). In addition, the article investigates the separate impact of relational embeddedness and structural embeddedness on research quality. There may exist joint effects of the above two factors, which may be investigated in future research.

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