Exploring the Influence of Returnees' Scientific Collaboration Networks on Research Performance

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Abstract: Returnee faculty play a pivotal role in international knowledge transfer and the advancement of scientific research within domestic universities. However, the effectiveness of returnees in enhancing institutional research performance remains inadequately understood. This study seeks to quantify and examine the collaborative academic networks of returnee faculty, assessing their impact on research output and funding performance. Based on an extensive academic dataset, comprehensive scientific collaboration networks (SCN) of returnees were constructed and empirically analyzed to elucidate the influence mechanisms underpinning research performance. The findings indicate that the presence of returnee faculty substantially enhances overall publication output and funding acquisition. Further, within the SCN of returnees, both academic influence and network expansion positively correlate with research productivity and funding success, whereas an increase in cooperation density appears to exert a negative effect. Additionally, the evolution of these collaboration networks was explored, revealing that returnees' SCN display lower similarity and retention over time compared to those of native faculty. These insights offer a valuable theoretical basis for improving the management and integration of returnee faculty and optimizing the allocation of higher education resources, thereby fostering more effective pathways for enhancing institutional research outcomes.

Keywords: Returnee faculty; Scientific collaboration networks (SCN); Social network theory; Research performance

1. Introduction

As a unique force in discipline construction and talent cultivation, returnees have built an important bridge for SCN (Newman, 2001), and played a leading role in transforming teaching, leading academic research, and strengthening social service (Li & Xue, 2021; Li & Zhu, 2020). However, due to their detachment from the local academic environment and the systematic differences in scientific research at home and abroad, returnees are faced with the dilemma of choosing between internationalization and localization and encounter the problem of an "academic hard landing" (Zhu, 2017). In this context, how effective is the integration of returnee faculty members in fostering research collaboration at universities? What has been their performance? What is the role of local faculty members in leading such collaborations in China? Exploring these questions is important for improving the talent management measures of universities, promoting the quality and efficiency of the management of returnee faculty in universities, and improving the scientific level of university faculty (Li et al., 2019).

In recent years, studies on SCN in higher education have highlighted their importance for advancing knowledge and increasing research impact (Noben et al., 2022). Academic collaboration is growing due to expanding higher education networks, specialized knowledge requirements, and improved communication infrastructure (Lee & Bozeman, 2005). Research shows that collaboration networks boost productivity, facilitate knowledge sharing,

and foster interdisciplinary innovation (Dusdal & Powell, 2021).

Research on SCN has focused on two dimensions: the network relationship and the network structure. The network relationship dimension mainly affects the effect of scientific research cooperation, and the intensity of cooperation inhibits the diversity of scientific research partners, thus weakening the performance of scientific research innovation. However, the diversity of cooperation can enhance innovation. Liu et al. (2018) found that previous strong relationships in scholars' collaboration networks strengthen current relationships but inhibit the establishment of new relationships, reducing the research team's novelty. The more convergent the network structure is, the less likely it is to attract new talent to join the collaboration networks. In addition, the lack of new talent reduces the opportunities for researchers to access new knowledge and the degree of knowledge innovation, which are not conducive to enhancing creativity. Focusing on international medical informatics rather than universities, Zhang et al. (2019) found that the diversity and stability of cooperation can significantly enhance research output, whereas the intensity of cooperation reduces research output. Increasing the diversity of partners and actively collaborating with scholars from different academic backgrounds can improve the quality and quantity of their publications. Zou et al. (2020) analyzed the cooperation networks of cross-strait tourism scholars. They found that the relationship strength can significantly enhance knowledge innovation. At the same time, cooperation density reduces the performance of knowledge innovation, i.e., as the cooperation becomes closer, the knowledge diversity decreases, weakening innovation output. Additionally, the centrality of the cooperation networks and the structural holes can significantly enhance knowledge innovation performance, and increased communication and interaction between members enriches knowledge diversity.

The existing literature has explored the importance and mechanisms of scholarly collaboration networks; however, there is limited research on how the integration of overseas academic talent impacts the research performance of university collaboration networks, particularly from the perspective of universities' internal management. Studies on returnees have mainly focused on adaptation to returning to China (Wu & Zhou, 2020; Yu & Yu, 2023), job satisfaction (Li & Xue, 2021), introduction policy (Shen & Tan, 2022), and teaching performance (Ma & Zhang, 2020). From the perspective of university management, there is a research gap in analyzing the academic cooperation between returnees and native teachers (Liu et al., 2018; Zhang et al., 2019). Therefore, from the perspective of university management and based on social network theory, this study explores the mechanism of academic cooperation between returnees and native teachers in terms of the research performance of their universities (publication and research funding), aiming to provide rational suggestions to universities to improve their research management mechanisms.

2. Theoretical Framework and Hypothesis Development

2.1 Theoretical Framework

• Social network theory

Social network theory, often referred to as network theory or network analysis, is a theory and method for studying social structures and the interactions between individuals (Borgatti et al., 2009; Horak et al., 2019). It focuses on the connections and interactions between individuals (or organizations, groups) within a society and how these connections impact information dissemination, resource flow, social influence, and other areas.

Current research in social network theory mainly focuses on the levels of analysis, involving individuals (such as opinion leaders, internet users, and survey respondents), organizations (such as upstream and downstream enterprises in supply chains, research institutions, and universities), or entire networks (Weir & Ali, 2024). For example, Moolenaar (2012) utilized social network theory and methods to analyze how teacher collaboration supports or constrains teaching, learning, and educational reform. The study's findings indicate that patterns of social relationships among teachers can greatly enhance the understanding of teacher collaboration and contribute to student learning, teachers' instructional practices, and the implementation of reforms.

With the help of social network theory, the SCN were constructed based on scientific research data in this study, aiming to reveal the mechanism of the influence of the integration of returnees on the existing SCN.

• Social capital theory

Social capital theory is a theoretical framework for studying how individuals or groups accumulate resources and gain benefits through social networks, relationships, and trust (Bourdieu, 1986). Social capital refers to the resources accumulated within social relationships, including trust, norms, information, and support, which can help individuals or groups achieve personal or collective goals (Putnam, 1995). Social capital theory has been widely applied in fields such as education, economics, public policy, and management, aiming primarily to explain the role of networks and relationships in resource acquisition, innovation, and performance improvement (Ali-Hassan, 2009). For example, Pan et al. (2023) expanded the research team into a collaborative network and analyzed the role of internal social capital in the relationship between collaboration strategies and academic output in high-output and low-investment collaborative networks. The results showed that in high-output collaborative

networks, internal social capital strengthened the impact of collaboration strategies on academic output, whereas in low-output collaborative networks, internal social capital suppressed this relationship.

The close ties between collaborators in a collaborative network and the value they bring (research performance) have been viewed in the literature as social capital, arguing that as collaboration deepens, social norms and trust between academics are built up through the collaboration and constitute a form of social capital in academia. Based on this idea and focusing on the group of returnees, this study tries to use structural characteristic indicators to represent the social capital of SCN and explore the influence mechanism of the social capital of returnees' SCN on research performance.

2.2 Hypothesis Development

Social capital positively affects both knowledge creation and absorption (Ortiz et al., 2018). Returnees with more research achievements have significantly more collaborations with the rest of the faculty, and they become the core members of research cooperation with rich social capital (Welch & Jie, 2013), occupying the central position of the organization. The returnee faculty with more achievements and strong scientific research ability transfer new ideas and theories from their overseas study experience to the university (Zhang & Peng, 2011). New knowledge can be better absorbed and utilized by other teachers, thereby improving the overall scientific research performance of the university (Gong et al., 2024). The following hypothesis was proposed:

H1: Collaborative influence positively affects the research performance of returnee faculty.

However, in collaboration networks, the increased strength of cooperative relationships can increase the interaction and cooperation among teachers and effectively improve communication efficiency. However, for academic research, the more stable the collaboration networks are, the more detrimental they are to the performance of exploratory innovation. Zhang & Peng (2011) found that network density is negatively correlated with organizational performance, which is consistent with the conclusion that too close a connection between members of academic collaboration is likely to lead to "collective blindness" and is detrimental to the improvement of research performance. The following hypothesis was proposed:

H2: A partnership's strength negatively affects the research performance of returnee faculty.

High heterogeneous knowledge acquisition ability positively affects performance (Liu et al., 2021; Tao et al., 2020). For returnees, high heterogeneous knowledge acquisition ability can make full use of the advantages of their overseas cooperation networks in academic cooperation and integrate the information and resources from different countries with different knowledge backgrounds, which enables other teachers in their universities to obtain richer knowledge and resources, thereby improving the research performance. The following hypothesis was proposed:

H3: Higher heterogeneous knowledge acquisition is associated with higher research performance of returnee faculty.

Cai et al. (2021) found in their empirical analysis of alliance relationship evolution that relationship expansion would positively and significantly affect innovation performance. In this study, SCN showed different degrees of expansion because of time, the increase in the number of faculty members, the implementation of the talent introduction policy and faculty initiative to seek academic cooperation. The expansion of the cooperation networks implies that many collaborators would join the SCN, which promotes the flow and transformation of knowledge and brings richer academic resources and broader network resources to the research team (Yang et al., 2022). Therefore, the following hypothesis was proposed:

H4: SCN expansion positively affects the research performance of returnee faculty.

Returnees act as a bridge for overseas communication and collaboration, and play an active role in systematic teaching change, promotion of professional research, and enhancement of social service and other performance, generating a spillover effect (Sun et al., 2021; Trippl, 2013). The equilibrium status of the domestic and foreign working environment and the depth of cooperation with foreign scholars of returnees significantly improve the quality of research output (Zhu, 2017). Therefore, the following hypothesis was proposed:

H5: Returnee faculty joining a university's SCN positively affects university research performance.

3. Research Design

3.1 Sample Description

Z University is one of China's top three universities specializing in finance and economics, with its Applied Economics program rated A+. In recent years, most newly recruited faculty members with overseas experience

have been in economics-related fields. The returnee faculty have strengthened Z University's teaching team, playing an active role in student development, academic program enhancement, and research advancement. Focusing on the faculty members with overseas experience at Z University, this study explores the impact of their academic collaboration networks on research performance. Such research holds theoretical significance for understanding the mechanisms by which returnee faculty contribute to academic program development and research advancement, thereby enhancing the management of overseas-trained faculty in finance and economics universities. This study reviewed and collected basic information (gender, age, faculty, etc.), scientific research data, such as publication and funding, and funding cooperation information (manually supplemented due to missing data) for 1,803 enrolled faculty members (including 193 returnee faculty members) at Z University from 2007 to 2020, as recorded in the university's personnel and scientific research systems. According to the Research Department's classification at Z University, funding types are divided into Class A, Class B, and Class C. Class A projects include major national and ministerial projects, while Class B projects encompass other national and ministerial projects. All remaining projects fall under Class C. Additionally, based on Z University's catalog of 206 Chinese journals and 408 foreign journals, papers published in AAA, AA, and A-tier Chinese and foreign journals are defined as high-level publications.

The final dataset was formed by removing data from papers and funding where the first author of the paper and the funding applicant only collaborated academically with faculty members from outside the university instead of those from the university. The sample of the whole university faculty is an unbalanced panel dataset of 7,572 observations. The sample for the returnee faculty's paper collaboration networks is an unbalanced panel dataset of 204 observations. The sample for the returnee faculty's program collaboration networks is an unbalanced panel dataset of 234 observations.

3.2 Description of Variables and Descriptive Statistics

The explanatory variables are paper performance and program performance. By referring to the study by Fan et al. (2015), combined with the actual situation of the Z University, the number of high-level papers in the Z University's journal catalog of Class A (inclusive) or higher was selected in this study to measure paper performance and the number of national-level (inclusive) or higher subject funding to measure funding performance.

The explanatory variables included static and dynamic characteristics of the returnee faculty's cooperation networks. The static characteristics were measured using the variables of cooperation influence, cooperation relationship strength, and heterogeneous knowledge acquisition ability, which describe the influence, cooperation closeness, and bridge connectivity of the returnee faculty in academic cooperation, respectively. The variable of cooperation network expansion was used to measure the evolutionary characteristics of collaboration networks.

Collaborative impact, representing the centrality of returnee faculty in the collaborative networks, was measured by the relative degree centrality of the SCN from 2007 to 2020. The calculation formula is: $RD = \frac{d}{n-1}$, where n is the network size (number of collaborating teachers), and d is the number of collaborators with whom the teacher works directly. Relative degree centrality compensates for the interaction between absolute centrality and network size, i.e., the ratio of the number of times a node is connected to other nodes to the maximum possible number of times. In this study, the degree centrality metric was used to measure whether a teacher node is central, reflecting the amount of power it possesses.

The strength of the partnership, which represents the closeness of the ties between faculty members in a research collaboration, was measured by the density of the individual network of academic collaborators. It is calculated by the formula $density = \frac{2l}{n(n-1)}$, where n is the number of faculty members; l is the number of paper collaborations between the returnee faculty and other teachers in the university; and $n*(n-1)$ is the maximum possible number of collaborations between the returnee faculty and other teachers in the university.

Heterogeneous knowledge acquisition ability was measured by teachers' structural holes in academic collaboration. Referring to the study by Newman & Girvan (2004), the mediating centrality degree was chosen in this study to measure structural holes. The calculation formula is as follows: $RB = \frac{2AB_i}{n^2-3n+2}$, where n is the number of shortcuts between two nodes at points j and k; and i is the third node. In the network structure, the mediating centrality degree reaches its maximum value at the star network structure $n^2 - 3n + 2$. The structural hole represents the control degree of a node over the resources. If a node is located in the shortest way to connect many other nodes simultaneously, this node has a high degree of intermediary centrality, and the role of the bridge connectivity is stronger.

Cooperation network expansion, which was used to measure whether the size of the SCN of returnees increases. A value of 1 is assigned when returnee teacher i adds new collaborators in period t over period $t-1$, and 0 otherwise.

Returnee faculty joining, which was used to measure the impact of returnee faculty on the overall research performance of the university, indicates whether there are returnee faculty in the research cooperation networks. A value of 1 is assigned if there are returnee faculty, and 0 otherwise.

Based on existing studies on the factors influencing performance, length of time in service and age were selected as variables in this study. The length of in-service time is the difference between the corresponding year of publication or subject funding declaration and the year of teachers' entry into the profession. The descriptive statistics of the variables are shown in Table 1, Table 2, and Table 3.

Table 1. Descriptive statistics results (all teachers)

Variable	Observed Value	Average Value	Standard Error	Minimum Value	Maximum Value
Publication performance (all teachers)	7572	2.976	3.214	1	24
Funding performance (all teachers)	7572	1.292	0.571	1	4
Returnees joining collaboration	7572	0.735	0.441	0	1
Length of service	7572	6.601	5.531	0	34
Age	7572	42.541	6.862	29	68

Table 2. Descriptive statistics results (returnees' SCN based on publication, SCN-P)

Variable	Observed Value	Average Value	Standard Error	Minimum Value	Maximum Value
Publication performance	204	1.431	0.928	1	9
Collaborative impact	204	0.002	0.003	0	0.053
Strength of partnership	204	0.149	0.61	0	1
Heterogeneous knowledge acquisition capacity	204	0.112	0.324	0	3.316
Cooperation network expansion	204	0.091	0.289	0	1
Length of service	204	4.443	3.603	0	23
Age	204	41.011	5.899	31	63

Table 3. Descriptive statistics results (returnees' SCN based on funding, SCN-F)

Variable	Observed Value	Average Value	Standard Error	Minimum Value	Maximum Value
Funding performance	234	1.216	0.460	1	4
Collaborative impact	234	0.034	0.078	0.002	0.268
Strength of partnership	234	0.562	0.097	0	1
Heterogeneous knowledge acquisition capacity	234	0.103	0.569	0	9.074
Cooperation network expansion	234	0.151	0.442	0	1
Length of service	234	4.443	3.603	0	23
Age	234	41.011	5.899	31	63

4. Empirical Analysis

4.1 Characterization of Returnees' SCN

To highlight the characteristics of the returnees' SCN, the SCN of native teachers with those of returnee faculty were compared and analyzed in this study. Table 4 shows the comparative analysis results of the structural indicator characteristics of SCN of the returnee faculty and the native teachers from 2007 to 2020, including two kinds of scientific cooperation: publication and funding.

As shown in Table 4, the partnership strength of the returnee faculty is higher than that of the native teachers both in publication cooperation and funding cooperation. The intensity of the funding cooperation relationship of native teachers is higher than the publication cooperation relationship intensity. The intensity of the publication cooperation relationship is lower than 0.01, indicating that the publication cooperation of native teachers is relatively more decentralized. Network size and partnership strength are negatively correlated, i.e., the larger the network size, the smaller the partnership strength. Compared with native teachers, the university cooperation network of returnee faculty is smaller.

The overall distribution and comparison of faculty degree centrality were used to measure the research impact of teachers. The distribution of mediator centrality degrees of faculty academic collaboration is uneven, with the largest percentage of faculty between 0.1 and 0.2 at 42%, and 7.25% of faculty greater than 1.0. These 7.25% of teachers have more rights to dominate resources in the SCN, control the path of cooperation and communication with other teachers in the networks, and play an important bridge role. The proportion of returnee faculty is higher

than that of native teachers by less than 0.4, while the proportion of native teachers starts to be higher than that of returnee faculty by more than 0.4. Returnee faculty are mainly distributed in the range of less than 0.5, while the proportion of native teachers is higher in the range of more than 0.5. This indicates that native teachers mainly play the role of bridge in the SCN and have a higher ability to acquire and utilize information.

Table 4. Comparative analysis of the characteristics of SCN

Year	SCN-P		SCN-F		Year	SCN-P		SCN-F	
	Returnee	Native	Returnee	Native		Returnee	Native	Returnee	Native
2007	0	0.0132	0.2463	0.0396	2014	0.0658	0.0034	0.0419	0.0147
2008	0.2000	0.0099	0.0857	0.0205	2015	0.0411	0.0050	0.0244	0.0161
2009	0	0.0077	0.0763	0.0159	2016	0.0270	0.0044	0.0430	0.0202
2010	0.1550	0.0082	0.0517	0.0141	2017	0.0381	0.0044	0.0344	0.0172
2011	0.0833	0.0079	0.0860	0.0135	2018	0.0341	0.0039	0.0361	0.0186
2012	0.1061	0.0058	0.0420	0.0141	2019	0.0214	0.0031	0.0637	0.0141
2013	0.2000	0.0038	0.0351	0.0133	2020	0.0156	0.0155	0.0580	0.0200

4.2 Analysis of the Evolution of Returnees' SCN

Path dependence is of great significance for analyzing the dynamic evolution of social networks. Based on the path dependence theory, the path dependence of the evolution of SCN of teachers in University Z was examined. SCN have path dependence characteristics and a knowledge diffusion effect, which has a direct impact on the characteristics of the cooperation networks, productivity, and its impact (Paraskevopoulos et al., 2020). The stronger the path dependence, the less academic innovation vigor can be.

By defining the network before each year as the "old network" and that in the new year as the "new network", this study analyzed the overlap between the collaborative networks in different years and how much of the old network continues into the new network. This was quantified using network similarity and network retention. The formulas are as follows:

$$net_{sim} = \frac{|net_{old} \cap net_{new}|}{|net_{old} \cup net_{new}|} \quad (1)$$

$$net_{kept} = \frac{|net_{old} \cap net_{new}|}{|net_{old}|} \quad (2)$$

where, net_{sim} is the network similarity, which measures the similarity between the old and new networks. The percentage of members that exist in both old and new networks is calculated in the concatenation of the two networks. The larger the percentage, the higher the network similarity. net_{kept} measures the proportion of old collaborators in the new network that remain cooperative for the network retention degree. The percentage of members in both the old and new networks that are present in the old network was calculated. The larger the percentage, the better the old network is maintained.

Table 5. Path dependency analysis of the SCN results

Year	SCN-P				SCN-F			
	Network Similarity		Network Retention		Network Similarity		Network Retention	
	Returnee	Native	Returnee	Native	Returnee	Native	Returnee	Native
2009	0.00%	15.98%	0.00%	29.67%	10.61%	16.49%	24.14%	37.70%
2010	6.90%	10.89%	8.00%	25.96%	5.97%	16.67%	21.88%	29.70%
2011	37.84%	15.09%	56.00%	25.29%	6.85%	11.97%	10.00%	22.12%
2012	7.41%	13.26%	12.50%	23.57%	8.47%	15.40%	16.67%	26.41%
2013	0.00%	12.65%	0.00%	32.91%	7.33%	16.62%	21.28%	29.33%
2014	0.00%	15.99%	0.00%	29.61%	11.80%	17.29%	13.58%	31.22%
2015	4.88%	11.39%	10.00%	16.95%	12.50%	16.87%	26.25%	26.52%
2016	11.67%	13.68%	11.82%	25.44%	5.05%	9.38%	20.17%	15.00%
2017	2.53%	14.06%	4.55%	24.90%	8.95%	9.78%	10.31%	18.90%
2018	11.43%	12.68%	22.22%	24.12%	9.55%	5.33%	15.32%	9.29%
2019	10.00%	16.46%	31.71%	36.86%	7.04%	8.61%	15.63%	22.37%
Mean	8.42%	13.83%	16.07%	26.84%	8.56%	13.13%	16.75%	24.42%

Detailed information on academic collaborations of 1,790 faculty members at University Z, including returnee and local faculty members, from 2009 to 2019, was used to analyze the dynamic evolution characteristics of the networks through indicators, such as network similarity and network retention. The results of the calculations are shown in Table 5.

Table 5 shows that in terms of paper collaboration, the network similarity of academic collaboration of returnee faculty (8.42%) is significantly lower than that of native teachers (13.83%). The network retention of returnee faculty (16.07%) is significantly lower than that of native teachers (26.84%). In terms of program collaboration, the network similarity of returnee faculty (8.56%) is significantly lower than that of native teachers (13.13%). The degree of collaboration network retention of returnee faculty (16.75%) is significantly lower than that of native teachers (24.42%). Therefore, the indicators of network similarity and network retention of academic collaborations of returnee faculty are lower than those of native teachers in publication and funding collaborations. Returnees' SCN are more dynamic with a greater magnitude of change.

4.3 Regression Analysis

Unbalanced dynamic panel data was utilized for specific analysis by constructing a fixed effect model. F-test and Hausman tests were conducted, and the results show that the fixed effect model should be chosen.

First, the effect of cooperation network characteristics on the research performance of returnee faculty was analyzed. As shown in Table 6, Models 1 and 2 take publication performance as the explanatory variable, and Models 3 and 4 take funding performance as the explanatory variable. The results show that the influence of collaboration is significantly and positively related to returnee faculty's publication ($\beta=0.275$, $p<0.01$) and funding performance ($\beta=0.011$, $p<0.05$); thus, H1 is supported. Collaborative relationship strength is significantly and negatively correlated with returnee faculty's paper performance ($\beta=-0.016$, $p<0.05$), and is significantly and negatively correlated with program performance ($\beta=-0.018$, $p<0.05$); thus, H2 is supported. Heterogeneous knowledge acquisition has no significant effect on returnee faculty's paper performance, but it is significantly positively related to program performance ($\beta=0.857$, $p<0.01$); thus, H3 is partially supported. Cooperation network expansion is significantly and positively related to returnee faculty's paper performance ($\beta=0.387$, $p<0.01$) and program performance ($\beta=0.114$, $p<0.01$); thus, H4 is supported.

Table 6. Impact of intramural cooperation network characteristics on research performance

	Publication Performance		Funding Performance	
	Model 1	Model 2	Model 3	Model 4
Collaborative impact		0.275*** (3.29)		0.011** (2.31)
Strength of partnership		-0.016** (-1.99)		-0.018** (-2.43)
Heterogeneous knowledge acquisition capacity		-0.020 (-0.84)		0.857*** (3.41)
Cooperation network expansion		0.387*** (32.09)		0.114*** (23.99)
Length of service	0.091** (2.12)	0.089** (2.09)	0.003*** (2.66)	0.009** (2.19)
Age	-0.991* (-1.74)	-0.912* (-1.82)	-0.012** (-1.99)	-0.005** (-2.45)
Constant	1.719** (2.54)	0.903 (1.03)	2.112*** (7.58)	2.051*** (5.44)
F	6.97	5.71	6.97	5.71
R^2	0.267	0.285	0.183	0.195
Observed value	204	204	234	234

Note: ***, **, and * represent significance at the 1%, 5% and 10 % levels, respectively.

Table 7. Results of the effect of returnee faculty joining the collaboration on research performance

	Publication Performance		Funding Performance	
	Model 5	Model 6	Model 7	Model 8
Returnee faculty joining cooperation		1.469*** (27.70)		0.015* (1.81)
Length of service	0.091** (2.12)	0.089** (2.09)	0.014* (1.82)	0.899* (1.81)
Age	-0.991 (-1.54)	-0.912 (-1.12)	-0.002 (-0.33)	-0.001 (-1.41)
Constant	0.543*** (45.04)	0.230*** (35.06)	0.015*** (44.22)	0.025*** (39.41)
F	789.32	767.09	231.34	229.44
R^2	0.029	0.028	0.043	0.041
Observed value	7572	7572	7572	7572

Note: ***, **, and * represent significance at the 1%, 5% and 10 % levels, respectively.

Second, the impact of returnee faculty joining on the overall research performance of the university was analyzed. As shown in Table 7, Models 5 and 6 take publication performance as the explanatory variable, and returnee faculty joining academic cooperation is significantly and positively related to the university's publication performance ($\beta=1.469$, $p<0.01$). Models 7 and 8, with program performance as the explanatory variable, show that returnee faculty joining academic cooperation is significantly and positively related to the university's program

performance (β=0.015, p<0.1); thus, H5 is supported.

To test the robustness of the results of the empirical model and ensure that the conclusions of the study are more reliable, the data of early academic cooperation in 2007 and 2008 were deleted, and the samples after implementing the new version of the scientific research catalog in 2020 were excluded. The test was repeated for the remaining samples, and the regression results are shown in Table 8. Regardless of whether control variables were added or not, the results did not change significantly. The parameter estimation results of each model are consistent with the previous analysis, and the conclusions of this study have strong explanatory power.

Table 8. Robustness test

	Publication Performance		Funding Performance	
	Model 9	Model 10	Model 11	Model 12
Collaborative impact		0.337^{***} (3.15)		0.051^{**} (2.31)
Strength of partnership		-0.010^{*} (-1.79)		-0.018^{**} (-2.43)
Heterogeneous knowledge acquisition capacity		0.006 (0.28)		0.815^{***} (3.99)
Cooperation network expansion		0.228^{***} (42.76)		0.129^{**} (22.32)
Length of service	0.082^{***} (2.98)	0.087^{**} (2.31)	0.013^{**} (1.97)	0.047^{**} (2.51)
Age	-1.014^{**} (-1.97)	-0.881^{***} (-2.84)	-0.047^{*} (-1.78)	-0.032^{***} (-7.38)
Constant	-0.277 (-1.22)	-0.450 (-0.25)	2.345^{***} (6.29)	1.600^{*} (1.73)
F	6.974	5.71	6.974	5.71
R^2	0.2437	0.3013	0.2264	0.3036
Observed value	182	182	218	218

Note: ***, **, and * represent significance at the 1%, 5% and 10 % levels, respectively.

The empirical results show that the greater the influence of the academic network cooperation of returnee faculty and the stronger the heterogeneous knowledge acquisition ability, the expanding scope of the collaboration network can significantly improve research performance. In contrast, the more closely connected the team members are and the more stable the collaboration networks, the more detrimental to improving research performance. This validates the important influence of enhancing the vitality of SCN on research performance. Meanwhile, the addition of returnee faculty members also significantly enhanced the research performance of the whole university. This indicates that the academic cooperation incentive policy introduced by Z University has achieved a significant effect on academic cooperation of returnee faculty. The SCN of returnees are more dynamic those of native teachers. Introducing returnee faculty has created a "catfish effect" in the academic partnerships of the university, which has stimulated the development of the native teachers, and, in turn, has improved the overall research performance of the university.

However, heterogeneous knowledge acquisition ability does not have a significant effect on returnee faculty's paper performance; it only affects funding performance. This suggests that the performance of returnee faculty in funding collaboration is more advantageous than paper collaboration. This is closely related to the current policy of Z University, which is more inclined to fund and assess funding teams, and has fewer policies about paper collaboration, team building, and especially the incubation mechanism of new teams.

To carry out a comparative analysis, this study also empirically examined the effect of heterogeneous knowledge acquisition capacity on performance in the SCN of native teachers. It was found that native teachers' heterogeneous knowledge acquisition ability is significantly and positively related to paper (β=0.269, p<0.05) and program performance (β=0.133, p<0.01). In contrast, the heterogeneous knowledge acquisition ability of returnee faculty does not enhance paper performance. Heterogeneous knowledge acquisition ability (network structural holes), the ability to control core resources, and the role of bridge connectivity in collaborative networks can promote research cooperation in cross-disciplinary backgrounds, realize the rapid integration of resources and control the flow of knowledge and information, improving scientific research performance. The returnee faculty members do not play a sufficient bridge role in paper collaboration.

Additionally, returnee faculty have strong individual needs in terms of academic cooperation, start-up funds, talent programs, funding application support, etc. The current management policy for returnee faculty at Z University is relatively single-minded, mostly favoring the introduction and appointment requirements of returnee faculty. A management policy must be developed for the subsequent growth and development of the returnee faculty.

5. Conclusion

This study analyzed four SCN characteristics: cooperation influence, cooperation relationship strength, heterogeneous knowledge acquisition ability and cooperation network expansion. Comparative analysis with native teachers revealed that the strength of the cooperative relationships of returnee faculty is higher than that of native teachers, whether in publication or funding cooperation. The index of scientific research influence indicated that native teachers are mainly those who play the role of "bridging" in SCN and are more capable of acquiring

and utilizing information. Furthermore, through path dependence analysis, it was found that network similarity and retention of returnees' SCN are lower than those of native teachers. Additionally, the returnees' SCN have a greater range of change and are more dynamic.

This study examined the influence of collaboration network characteristics on paper and funding performance and found that in the academic collaboration networks of returnee faculty, cooperation exerts a positive and significant influence on both paper and funding performance. In the academic collaboration networks of returnee faculty, the intensity of cooperative relationships exerts a significant and negative influence on paper and funding performance. In the academic collaboration networks of returnee faculty, the heterogeneous knowledge acquisition ability does not have a significant effect on paper performance, but exerts a significant negative effect on program performance. In addition, expanding the SCN of returnees has a positive and significant effect on paper and program performance.

This study's sample only focused on the academic partnership between returnee faculty and native teachers in a specific university, which belongs to the intraorganizational partnership network. The sample coverage was lacking. Future research could consider expanding the sample, obtaining data from other universities to study intraorganizational academic partnerships, or integrating the samples of several universities to study a cross-organizational academic partnership network.

Data Availability

The data used to support the research findings are available from the corresponding author upon request.

Conflicts of Interest

The authors declare no conflict of interest.

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