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Academic Affiliation Structure and Provincial First-Class Discipline Construction: A Quantitative Study of 60 First-Class Disciplines in Liaoning Province

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Abstract: The development of high-quality faculty constitutes the foundational task for constructing first-class disciplines, wherein the optimization of academic affiliation structure plays a critical role in building high-level faculty teams for provincial first-class disciplines. Based on the academic CVs of 5,179 university teachers in Liaoning Province, this study examines the characteristics of academic affiliation structure across 60 first-class disciplines from three dimensions: types of academic affiliation, heterogeneity of academic affiliation structure, and centrality of academic affiliation networks. The findings reveal that the proportion of inbred faculty in Liaoning universities is generally high, with notable disciplinary variations. Herfindahl-Hirschman Index (HHI) scores differ significantly across institutions and disciplines, indicating pronounced heterogeneity in academic affiliation structure. The academic affiliation network exhibits a typical core-periphery structure, with a small number of institutions demonstrating high network centrality, and clear stratified and partitioned characteristics. Accordingly, universities in Liaoning should further optimize the academic affiliation structure of faculty, enhance the organizational openness of first-class discipline construction, and improve the overall quality of disciplines.

Keywords: First-Class Disciplines; Academic Affiliation Structure; University Faculty; Hiring Network

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1.Introduction

The development of world-class universities and disciplines is a major strategic decision by China in the field of education, one that is vital for enhancing the competitiveness of its higher education system, and by extension, the nation's overall strength. Since the launch of the national "Double First-Class" initiative, each province, autonomous region, and centrally administered municipality has issued local implementation plans. Through a series of region-specific policies, these provinces have supported the construction of world-class universities and disciplines, creating a province-level momentum for the "Double First-Class" endeavor. At the heart of this effort lies the cultivation of first-rate disciplines, which has become a key driver of universities' pursuit of connotative, quality-oriented development. In 2017, the People's Government of Liaoning Province released the Implementation Plan for Coordinating the Development of World-Class Universities and Disciplines

in Liaoning Province, designating 65 disciplines across 22 universities as priority areas for development [1]. In 2018, the Liaoning Provincial Department of Education announced a dynamic-adjustment mechanism, expanding the number of targeted disciplines from 65 to 110 and categorizing them into Tier A and Tier B for differentiated support [2]. In 2021, the Liaoning 14th Five-Year Plan for Educational Development set out a goal to build a "Two-Ten, Two-Hundred" disciplinary system [3]. In 2024, the Liaoning Provincial Department of Education issued the Implementation Plan for Deepening the Development of World-Class Universities and Disciplines in Liaoning Province (2024–2028), officially launching the province's second round of the "Double First-Class" initiative. Throughout policy implementation, Liaoning has instituted performance appraisals for first-class discipline projects, evaluating them on multidimensional indicators such as faculty strength, talent cultivation, scientific research, social service, and international collaboration. This approach exemplifies the province-level practice in the national "Double First-Class" construction.

Faculty strength serves as a crucial foundation for the construction of first-class disciplines. In the context of first-class discipline development, provincial governments have introduced corresponding plans for faculty recruitment and cultivation [4], emphasizing the pivotal role of high-level faculty teams in talent cultivation and scientific research. As a characteristic indicator of teachers' "academic origins," academic affiliation reflects the natural state of faculty sources [5], and its structure can reveal the relational dimensions of talent resource allocation and integration within disciplinary organizations. Therefore, the academic affiliation structure of faculty is both a practical reflection of faculty development and a supporting element for the growth of disciplinary organizations. A well-structured academic affiliation can promote the healthy development of disciplinary organizations and enhance the overall quality of university discipline development. Existing literature primarily examines the academic affiliation structure of faculty in research universities through topics such as academic "inbreeding" [6-8], doctoral hiring networks [9-10], and talent agglomeration and mobility [11-12], providing relevant evidence for first-class discipline construction. However, the significance of academic affiliation structure in provincial first-class discipline development has not received sufficient attention, and empirical research remains relatively scarce. Although provincial first-class discipline construction carries policy implications for advancing high-level regional universities, few studies in practice have employed quantitative methods to uncover the potential value of faculty academic affiliation structure for faculty strength, resulting in an "insufficient supply" of research on provincial first-class discipline construction. To address this gap, this study focuses on 60 first-class disciplines in Liaoning Province, using faculty academic affiliation structure as an analytical lens. By examining multiple dimensions of academic affiliation structure, it measures its relationship with first-class discipline construction, aiming to provide empirical insights and decision-making references for provincial-level first-class discipline development and enrich the localized research on "Double First-Class" initiatives.

2.Literature Review

The construction of first-class disciplines, as a key component of the "Double First-Class" initiative, has long faced methodological challenges in effectiveness evaluation [13]. The academic affiliation structure of faculty, serving as a crucial indicator for assessing the composition of teaching staff, directly reflects the developmental status of first-class discipline construction in higher education institutions [14]. In terms of faculty recruitment, network metrics formed through mutual hiring relationships among PhD holders can also serve as indicators of disciplinary prestige [15], thereby establishing an academic affiliation-oriented dimension for first-class discipline development.

Drawing on faculty alma mater data [16], existing research on academic In terms of faculty recruitment, network metrics formed through mutual hiring relationships among PhD holders can also serve as indicators of disciplinary prestige [15], thereby establishing an academic affiliation-oriented dimension for first-class discipline development has concentrated on three dimensions—type, heterogeneity, and hiring networks. Some scholars, using "tie strength" as a criterion, classify academic affiliation into four relational categories—"natives," "in-house retainees," "outsiders," and "returnees"—and thereby illuminate how academic affiliation shapes faculty career trajectories [17]. Yan's survey [18] shows that the proportion of faculty who earned all three degrees (bachelor's, master's, and Ph.D.) at the same university is markedly higher than that of any other type of academic affiliation. Liu and colleagues argue that China's academic labor market is bifurcated into "inbred" and "non-inbred" groups whose interests are often in conflict [19]. As university rank descends, the share of "inbred"

group exhibits an inverted-U pattern, first rising and then falling [20]. Liu's [21] analysis further demonstrates that increasing the proportion of Ph.D. holders with inbred affiliation erodes academic vitality and, consequently, undermines the construction of world-class disciplines.

Based on faculty academic affiliation, various composite indicators can be employed to measure the academic affiliation structure of teaching staff [20,22]: the proportion of faculty with doctoral degrees [22], the percentage of returnees[14], and inter-institutional hiring rates among neighboring universities [11,23]. The "academic caste system" [24] prevalent in faculty hiring networks tends to result in homogeneous academic affiliation structures within institutions, while structural diversity represents the opposite scenario [25]. However, within the academic hierarchy, elite institutions rarely recruit graduates from lower-tier universities [26-27], highlighting the "prestige matching principle" [28]. From a regional perspective, universities in Northeast China exhibit relatively closed academic affiliation structures [25]. Furthermore, studies have confirmed a quadratic relationship between academic affiliation structure and research output [17].

Disciplinary organizations and their academic teams constitute the fundamental units for analyzing academic affiliation structures. Among the most frequently cited factors are organizational size [29], historical reputation [24,30], and geographical location. Li and colleagues classify hiring patterns into four principal types according to the faculty's academic affiliation [14]. From a mobility perspective, faculty who move laterally between peer-level disciplinary organizations perform best, whereas those who move upward outperform those who move downward [31]. Furthermore, Huang and colleagues highlight that homogenization of academic affiliation structure represents a critical barrier in the construction of first-class disciplines [32].

In summary, while faculty academic affiliation structure is closely linked to first-class discipline construction, quantitative research at the provincial level remains relatively scarce. Against the backdrop of a new phase of regional "Double First-Class" initiatives, this study focuses on 60 first-class disciplines in Liaoning Province. Through academic affiliation analysis, we examine typological differences; employ the heterogeneity of academic affiliation structure to measure the openness of disciplinary organizations; and utilize faculty hiring networks to reveal the regional influence of academic affiliation. The findings provide empirical support for China's regional "Double First-Class" advancement strategies.

3.Research Design

This study adopts manual CV data collection to obtain faculty information from the official websites of universities and departments affiliated with Liaoning Province's first-class disciplines. The dataset includes graduation institutions at the bachelor's, master's, and doctoral levels. We constructed the Liaoning First-Class Discipline Faculty Academic Affiliation Database to support analysis, monitoring, and updates regarding faculty composition and dynamics.

From the full list of 110 designated disciplines under Liaoning's "Double First-Class" initiative, this study selected 60 disciplines with complete faculty information, yielding a sample of 5,179 full-time teaching and research staff. For each scholar, data on their bachelor's, master's, and doctoral alma mater institutions were collected, enabling an analysis of academic affiliation structure.

This study employs CV analysis for data collection and organization. The Herfindahl-Hirschman Index (HHI) is used to measure the heterogeneity of academic affiliation structure, while three centrality measures from social network analysis—degree centrality, betweenness centrality, and closeness centrality—are applied to assess network centrality. UCINET 6 is used as the analytical platform, and NetDraw is employed for network visualization.

4.Empirical Analysis

4.1 The Overview of Liaoning's First-Class Disciplines

In accordance with the Implementation Plan for Coordinating the Development of World-Class Universities and Disciplines in Liaoning Province, the province groups its designated disciplines into five broad sectors—industry, agriculture, medicine, modern services, and social affairs—while taking into account institutional type and industry affiliation. The plan covers four ministries-affiliated universities, twenty-seven provincial universities, and two municipal universities. Overall, Liaoning's first-class disciplines are widely distributed across a diversified institutional landscape, generating synergistic innovation through differentiated development. Among all selected disciplines, Mechanical Engineering and Materials Science and

Engineering receive the strongest policy support, each being represented by five universities on the first-class list. Computer Science and Technology and Chemical Engineering and Technology are each pursued by four universities. In Liaoning—a traditional industrial powerhouse—first-tier disciplines within the engineering category receive particularly pronounced policy prioritization. Against the backdrop of revitalizing China's Northeast industrial base, the chosen disciplines are characterized by solid developmental foundations, distinctive industry relevance, and pronounced strengths in talent cultivation, making them both typical and representative cases for the "Double First-Class" initiatives of regional universities.

4.2 Analysis of Academic Affiliation Structure in First-Class Disciplines

4.2.1 Types of Academic Affiliation Structure

Academic affiliation refers to the relationship between a faculty member's degree-granting institution and their current employing institution. When the doctoral degree-granting institution is identical to the employing institution, the relationship is defined as inbred affiliation; otherwise, it is termed outbred affiliation. In practice, inbreeding can also occur at the bachelor's or master's level, indicating varying degrees of institutional self-recruitment[32-34].

Among the 60 first-class disciplines in Liaoning Province: Faculty with inbred bachelor's affiliation account for 43.24%; Faculty with inbred master's affiliation account for 52.05%; Faculty with inbred doctoral affiliation account for 50.78%; Faculty exhibiting inbreeding across two educational stages account for 17.41%; Faculty exhibiting inbreeding across all three stages account for 11.95%.

Table 1: The Distribution of First-class Disciplines among Universities in Liaoning Province

Discipline Category	Disciplines (Number of Universities)	University Distribution
Economics	Theoretical Economics (2)	Liaoning University, Dongbei University of Finance and Economics
	Applied Economics (2)	Liaoning University, Dongbei University of Finance and Economics
Law	Science of Law (1)	Liaoning University*
	Theory of Marxism (1)	Liaoning University
Education	Education (2)	Liaoning Normal University, Shenyang Normal University
	Psychology (1)	Liaoning Normal University*
	Physical Education and Sport Science (1)	Shenyang Sport University
Literature	Foreign Languages and Literatures (1)	Dalian University of Foreign Languages*
Science	Mathematics (1)	Dalian University of Technology*
	Physics (1)	Dalian University of Technology*
	Chemistry (2)	Dalian University of Technology, Northeastern University*
	Geography (1)	Liaoning Normal University
	Biology (2)	China Medical University, Dalian Medical University
	Statistics (2)	Liaoning University, Dongbei University of Finance and Economics
Engineering	Mechanics (1)	Dalian University of Technology*
	Mechanical Engineering (5)	Dalian University of Technology, Shenyang University of Technology, Northeastern University, Dalian Jiaotong University, Shenyang Jianzhu University

Discipline Category	Disciplines (Number of Universities)	University Distribution
Engineering	Instrumentation Science and Technology (2)	Dalian University of Technology, Shenyang University of Technology
	Materials Science and Engineering (5)	Dalian University of Technology, Shenyang University of Technology, Northeastern University, Dalian Jiaotong University, Shenyang Ligong University
	Metallurgical Engineering (1)	Northeastern University*
	Power Engineering and Engineering Thermal Physics (1)	Dalian University of Technology*
	Electrical Engineering (1)	Shenyang University of Technology*
	Information and Communication Engineering (2)	Dalian University of Technology, Northeastern University
	Control Science and Engineering (3)	Dalian University of Technology, Northeastern University, Liaoning University of Technology
	Computer Science and Technology (4)	Dalian University of Technology, Northeastern University, Dalian Maritime University, Shenyang Aerospace University
	Architecture (2)	Dalian University of Technology, Shenyang Jianzhu University
	Civil Engineering (2)	Dalian University of Technology, Shenyang Jianzhu University*
	Hydraulic Engineering (1)	Dalian University of Technology*
	Surveying and Mapping (1)	Liaoning Technical University
	Chemical Engineering and Technology (4)	Dalian University of Technology, University of Science and Technology Liaoning, Liaoning Petrochemical University, Shenyang University of Chemical Technology
	Mining Engineering (2)	Northeastern University, Liaoning Technical University*
	Textile Science and Engineering (1)	Dalian Polytechnic University*
	Light Industry Technology and Engineering (1)	Dalian Polytechnic University*
	Transportation Engineering (1)	Dalian Maritime University*
	Naval Architecture and Ocean Engineering (1)	Dalian Maritime University*
	Aerospace Science and Technology (1)	Shenyang Aerospace University
	Agricultural Engineering (1)	Shenyang Agricultural University
	Environmental Science and Engineering (3)	Dalian University of Technology, Dalian Maritime University, Shenyang University
	Food Science and Engineering (3)	Dalian Polytechnic University, Shenyang Agricultural University, Bohai University
	Urban and Rural Planning (2)	Dalian University of Technology, Shenyang Jianzhu University
	Landscape Architecture (1)	Shenyang Jianzhu University

Discipline Category	Disciplines (Number of Universities)	University Distribution
	Software Engineering (3)	Dalian University of Technology, Northeastern University, Dalian University
	Safety Science and Engineering (1)	Liaoning Technical University
	Public Security Technology (1)	Criminal Investigation Police University of China
Agriculture	Crop Science (1)	Shenyang Agricultural University
	Horticulture science (1)	Shenyang Agricultural University
	Agricultural Resource and Environment Science (1)	Shenyang Agricultural University
	Plant Protection (1)	Shenyang Agricultural University
	Veterinary Medicine (1)	Shenyang Agricultural University*
	Fisheries (1)	Dalian Ocean University
Medicine	Basic Medicine (3)	China Medical University, Dalian Medical University, Jinzhou Medical University
	Clinical Medicine (2)	China Medical University, Dalian Medical University
	Stomatology (1)	China Medical University
	Public Health and Preventive Medicine (1)	China Medical University
	Chinese Medicine (1)	Liaoning University of Traditional Chinese Medicine
	The Integrative Medicine (2)	Dalian Medical University, Liaoning University of Traditional Chinese Medicine
	Pharmaceutical Science (3)	China Medical University, Shenyang Pharmaceutical University, Liaoning University of Traditional Chinese Medicine
	Chinese Materia Medica (2)	Shenyang Pharmaceutical University, Liaoning University of Traditional Chinese Medicine
	Nursing (1)	China Medical University
Management	Management Science and Engineering (3)	Dalian University of Technology, Northeastern University, Dongbei University of Finance and Economics*
	Business Administration (3)	Liaoning University, Dalian University of Technology, Dongbei University of Finance and Economics*
	Public Administration (2)	Northeastern University, Dongbei University of Finance and Economics
Arts	Music and Dance (1)	Shenyang Conservatory of Music
	Fine Art (1)	Luxun Academy of Fine Arts
	Design (1)	Luxun Academy of Fine Arts

Note: The institutions of the sample disciplines are marked with *.·

As shown in Table 2, among the 60 first-class disciplines, the share of faculty who earned their bachelor's degrees in-house is approximately normally distributed: most disciplines fall between 30% and 60%, whereas very few fall below 10% or exceed 70%. At the master's level, 14 disciplines exhibit an in-house share of 60-70%. Doctoral inbreeding, however, varies markedly across disciplines, with a sizable number falling either below 10% or above 70%. The proportion of "inbred" academic affiliation differs by discipline. Materials Science and Engineering at Dalian University of Technology, Mechanical Engineering at Northeastern University, and Electrical Engineering at Shenyang University of Technology all display comparatively high levels of in-house doctoral hiring. Conversely, Public Administration at Dongbei University of Finance and Economics, Science of Law at Liaoning University, and Naval Architecture and Ocean Engineering at Dalian Maritime University exhibit markedly lower inbreeding rates. Traditional engineering fields show pronounced retention of their own graduates, a pattern closely linked to laboratory succession systems and the continuity of large-scale research projects. These disciplines, which concentrate substantial scientific resources, become "academic highlands." While such concentration can stabilize development in the short term, it may ultimately foster insularity, factionalism, and stagnation in innovation—outcomes that ultimately hinder first-class disciplinary development.

Table 2: Interval distribution of "inbred" degrees of faculty based on the number of subjects

Interval distribution	**[0%, 10%)**	**[10%, 20%)**	**[20%, 30%)**	**[30%, 40%)**	**[40%, 50%)**	**[50%, 60%)**	**[60%, 70%)**	**[70%, 80)**	**[80%, 90%)**
Bachelor-level alma mater	2	5	10	14	11	10	5	3	0
Master-level alma mater	2	1	9	10	10	8	14	3	3
Doctoral alma mater	11	4	2	5	3	14	5	13	3

4.2.2 The Heterogeneity of Academic Affiliation Structure

Academic affiliation reflect the connections between degree-granting institutions and faculty employment institutions. However, to assess the diversity of faculty educational backgrounds within a specific discipline, it is necessary to employ indicators measuring the heterogeneity of academic affiliation structure. The Herfindahl-Hirschman Index (HHI), a commonly used metric in economics, primarily measures industrial concentration or market share distribution among firms. The HHI and its modified formula demonstrate strong applicability in heterogeneity analysis. The specific formula is:

$$HHI = 1 - \sum P_i$$

In this formula, Pi denotes the percentage of graduates from the i-th alma mater within a given discipline. The Herfindahl–Hirschman Index (HHI) ranges from 0 to 1; a higher score indicates greater institutional heterogeneity of alma maters, whereas a lower score signals stronger homogeneity. Drawing on the distribution of faculty alma maters, this study measures the heterogeneity of academic affiliation structure across Liaoning's 60 first-class disciplines. Table 3 shows that Chemical Engineering and Technology at Liaoning Petrochemical University, Foreign Languages and Literatures at Dalian University of Foreign Languages, Food Science and Engineering at Dalian Polytechnic University, Public Administration at Dongbei University of Finance and Economics, and Light Industry Technology and Engineering at Dalian Polytechnic University register relatively high HHI scores, reflecting markedly heterogeneous academic affiliation. Conversely, Chinese Materia Medica at Shenyang Pharmaceutical University, Metallurgical Engineering at Northeastern University, Pharmaceutical Science at Shenyang Pharmaceutical University, Software Engineering at Northeastern University, and Business Administration at Dongbei University of Finance and Economics exhibit low HHI scores, indicating strong homogeneity. Comparatively, emerging disciplines—lacking entrenched academic factions—require greater external talent inflows, whereas mature disciplines, dominated by authoritative teams, tend to recruit doctoral graduates with "pure" academic lineages. Nevertheless, prevailing scholarly consensus holds that a diversified academic affiliation structure is indispensable for building world-class disciplines [16].

Table 3: HHI-Based Measurement of the Heterogeneity of Faculty Academic Affiliation structure in Liaoning's First-Class Disciplines

Rank	University Name	Discipline Name	Herfindahl Index	Rank	University Name	Discipline Name	Herfindahl Index
1	Liaoning Petrochemical University	Chemical Engineering and Technology	0.934	51	Liaoning Technical University	Mining Industrial Engineering	0.586
2	Dalian University of Foreign Languages	Foreign Languages and Literatures	0.933	52	Shenyang Agricultural University	Agricultural Resource and Environment Science	0.578
3	Dalian Polytechnic University	Food Science and Engineering	0.929	53	Dalian University of Technology	Hydraulic Engineering	0.518
4	Dongbei University of Finance and Economics	Public Administration	0.922	54	Northeastern University	Mechanical Engineering	0.516
5	Dalian Polytechnic University	Light Industry Technology and Engineering	0.913	55	Northeastern University	Mining Industrial Engineering	0.502
6	Shenyang Agricultural University	Veterinary Medicine	0.910	56	Shenyang Pharmaceutical University	Chinese Materia Medica	0.445
7	Dalian Maritime University	Transportation Engineering	0.906	57	Northeastern University	Metallurgical Engineering	0.435
8	Shenyang Normal University	Education	0.903	58	Shenyang Pharmaceutical University	Pharmaceutical Science	0.433
9	Dalian Polytechnic University	Textile Science and Engineering	0.890	59	Northeastern University	Software Engineering	0.416
10	Dalian Jiaotong University	Materials Science and Engineering	0.886	60	Dongbei University of Finance and Economics	Business Administration	0.368

4.2.3 The Centrality of Academic Affiliation Structure

Centrality describes an actor's position in a network, the strength of its relationships with other actors, and its degree of influence over others. Centrality can be divided into degree centrality, betweenness centrality, and closeness centrality [26]. Degree centrality measures an individual actor's connectivity within the network. Betweenness centrality measures an actor's capacity as an intermediary-its ability to control or regulate information flow [35]. Closeness centrality measures nodal influence by calculating the reciprocal of the sum of shortest-path distances from one node to all other nodes. Standardization eliminates the influence of factors like network size, making centrality comparable across different nodes in the network. The specific standardized formulas are as follows:

Normalized degree centrality: $C_D^*(n_i)=\frac{C_{D(n_i)}}{N-1}=\frac{\sum_j x_{ij}}{N-1}$

(where x_{ij} represents the number of faculty recruited by institution i from institution j, and N is the total number of institutions in the network)

Normalized betweenness centrality: $C_B^*(n_i)=\frac{C_{B(n_i)}}{(N-1)(N-2)/2}=\frac{2\sum_{j<k}\frac{g_{jk(n_i)}}{g_{jk}}}{(N-1)(N-2)}$

(where g_{jk} denotes the shortest path between institutions j and k)

Normalized closeness centrality: $C_C^*(n_i)=\frac{C_{C(n_i)}}{N-1}=(N-1)\cdot C_{C(n_i)}=\frac{N-1}{\sum_j d(n_i,n_j)}$

(where d_{jk} represents the shortest hiring chain length between institutions j and k)

Network centrality measures of faculty academic affiliation structure in Liaoning's first-class disciplines reveal the varying influence of institutions in talent cultivation and faculty recruitment. Combining multiple indices provides a comprehensive assessment of each institution's core position within the network and its role in shaping the academic affiliation landscape.

With a normalized degree centrality of 2.273, Dalian University of Technology ranks first, demonstrating exceptionally strong doctoral placement capacity. Northeastern University (0.720), Harbin Institute of Technology (0.473), and Jilin University (0.340) follow in second to fourth places, underscoring the dominant role of Northeast China institutions in faculty development.

Jilin University ranks first in betweenness centrality (5.625), indicating its pivotal position as a "talent channel" connecting different institutions and serving as a crucial hub for talent mobility in Northeast China. Dalian University of Technology (4.342) and Harbin Institute of Technology (4.068) follow closely. Additionally, Northeast Normal University (2.270) and Peking University (2.395) demonstrate relatively high betweenness centrality, highlighting their special role in facilitating cross-regional academic affiliation exchanges.

In the closeness centrality ranking, Jilin University (97.973) maintains its top position, demonstrating that its graduates can rapidly establish connections with other institutions and possess the strongest resource integration capability within Liaoning Province's academic affiliation network. Dalian University of Technology (95.395) and Harbin Institute of Technology (94.565) follow respectively. Prestigious out-of-province institutions like Zhejiang University (90.249) and Peking University (87.174) also show high closeness centrality, indicating their graduates exert extensive influence within Liaoning's higher education institutions.

Dalian University of Technology, Jilin University, Harbin Institute of Technology and Northeastern University have "academic brand effect" in the network, taking the top five among the three indicators, with the advantages of output, bridge and information integration. Institutions such as Peking University, Nankai University, and Northeast Normal University register higher betweenness and closeness centrality than degree centrality, indicating that their graduates function primarily as "bridging ties" within Liaoning's academic affiliation network. In addition, the Dalian Institute of Chemical Physics ,Chinese Academy of Sciences and Dongbei University of Finance and Economics display degree-centrality values markedly higher than their betweenness or closeness scores, reflecting a clear competitive edge for their PhDs in the provincial academic labor market. Overall, faculty mobility among Northeast Chinese universities is frequent, yet linkages to institutions outside the region remain comparatively weak—an outcome consistent with a regional culture of "in-group trust preference," compounded by high cross-regional recruitment costs and geographical disadvantages.

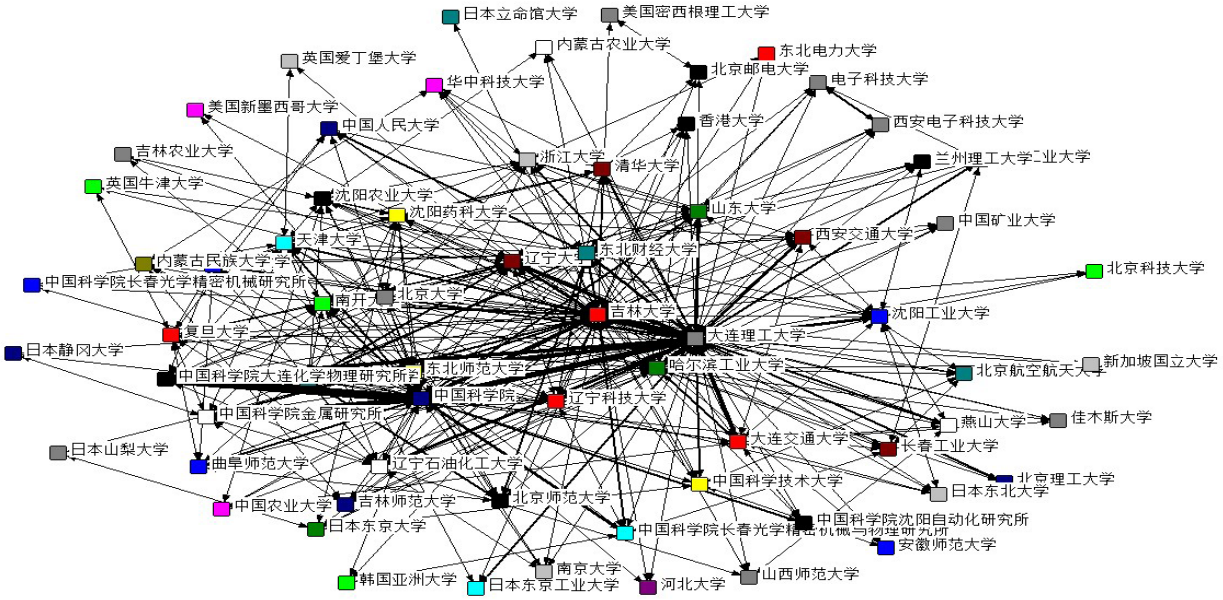
Table 4: Network Centrality and Rankings of Faculty Academic Affiliation Structures in Liaoning's First-Class Disciplines

No.	Graduation Institution	Degree Centrality	Degree Centrality Rank	Betweenness Centrality	Betweenness Centrality Rank	Closeness Centrality	Closeness Centrality Rank
1	Dalian University of Technology	2.273	1	4.342	2	95.395	2
2	Jilin University	0.34	4	5.625	1	97.973	1
3	Harbin Institute of Technology	0.473	3	4.068	3	94.565	3
4	Northeastern University	0.72	2	3.411	5	87.174	5
5	Zhejiang University	0.099	8	3.655	4	90.249	4
6	Peking University	0.077	11	2.395	6	87.174	6
7	Tsinghua University	0.122	6	1.356	10	82.386	9
8	Nankai University	0.06	17	2.269	8	85.63	7
9	Tianjin University	0.091	9	0.958	15	78.662	11
10	Nanjing University	0.05	22	1.206	12	79.67	10
11	Dalian Institute of Chemical Physics, Chinese Academy of Sciences	0.173	5	0.688	26	77.265	13
12	Northwestern Polytechnical University	0.066	12	0.737	23	77.265	14

No.	Graduation Institution	Degree Centrality	Degree Centrality Rank	Betweenness Centrality	Betweenness Centrality Rank	Closeness Centrality	Closeness Centrality Rank
13	Shanghai Jiao Tong University	0.061	16	0.742	21	76.991	18
14	Hiroshima University, Japan	0.048	23	1.288	11	75.521	24
15	Tongji University	0.056	19	0.741	22	76.855	19
16	Northeast Normal University	0.022	51	2.27	7	85.127	8
17	Institute of Metal Research, Chinese Academy of Sciences	0.063	14	0.592	30	75.784	23
18	Changchun Institute of Applied Chemistry, Chinese Academy of Sciences	0.041	26	0.688	27	77.265	15
19	Wuhan University	0.026	40	0.75	20	77.679	12
20	Beijing Normal University	0.045	25	1.082	13	73.854	35
21	Dongbei University of Finance and Economics	0.119	7	0.675	28	72.02	42
22	Changchun Institute of Optics, Fine Mechanics and Physics, Chinese Academy of Sciences	0.034	32	0.723	24	76.585	21
23	Xiamen University	0.033	33	0.935	16	74.359	32
24	Beihang University	0.063	13	0.396	41	74.614	28
25	Tohoku University, Japan	0.051	21	0.413	38	74.486	31
26	University of Science and Technology Beijing	0.024	46	0.723	25	76.585	20
27	Fudan University	0.045	24	0.396	40	74.614	29
28	Changwon National University, Korea	0.017	59	0.92	18	77.128	16
29	Liaoning Normal University	0.014	69	1.605	9	75.26	25
30	The University of Hong Kong	0.031	35	0.413	39	74.486	30

The relationships among first-class-discipline faculty across different alma maters create a network analogous to the "co-citation" networks found in scientometrics. This visualization depicts the degree of affinity among universities in terms of talent mobility. In Figure 1, each tie represents two institutions that share graduates now serving as faculty, and the thickness of the line is proportional to the number of such shared graduates. Owing to the large number of institutions, only universities and research organizations with ten or more mutual hires are displayed. It is immediately evident that faculty in Liaoning Province primarily secure positions through mobility within Northeast China; Dalian University of Technology, Jilin University, and Harbin Institute of Technology form the densest cluster of ties and occupy the core of the network, directing the flow of academic affiliation. Robust intra-regional ties among Northeast universities indicate frequent internal talent circulation, whereas inter-regional interactions remain sparse. Moreover, because a handful of institutions monopolize high-quality resources, peripheral universities struggle to break through structural barriers. With respect to returnees, faculty who studied in Japan are relatively numerous, yet Ph.D. holders from other world-class universities abroad are comparatively scarce. The network exhibits a pronounced core–periphery structure, underscoring the stratified and partitioned nature of faculty academic affiliation structure.

Figure 1: Visualization Network of Faculty Academic Affiliation Structure in Liaoning's First-Class Disciplines



5.Conclusion and Discussion

The foregoing analysis reveals the characteristics of faculty academic affiliation structure across Liaoning's 60 first-class disciplines. The principal findings are as follows:

A high proportion of faculty hold "inbred" academic affiliation, yet the prevalence differs by degree level, with the distribution across disciplines varying by stage.

The Herfindahl–Hirschman Index scores shows that the academic affiliation structure of Liaoning Province's first-class disciplines exhibits a marked institutional stratification. Within the same university, the heterogeneity scores of the academic affiliation structure vary greatly across disciplines; within the same discipline, the scores differ substantially across universities. Such divergence may lead to an "unbalanced" development of provincial first-class disciplines.

Social-network analysis demonstrates a classic core–periphery structure in the academic affiliation network. Universities in Northeast China are closely tied to the training of faculty in Liaoning's first-class disciplines. A small set of institutions consistently ranks at the top across multiple measures, occupying central and brokerage positions in the flow of academic resources, whereas peripheral institutions exert limited influence. Moreover, overseas affiliation are concentrated in only a few universities and have yet to diffuse broadly, a pattern that could constrain the province's capacity to enhance disciplinary development.

Talent recruitment and faculty appointment constitute critical issues in the development of provincial first-class disciplines. During the regional "Double First-Class" initiative, Liaoning Province should prioritize the optimization of faculty academic affiliation structure in higher education institutions, reducing rates of academic inbreeding. Through scientifically designed policies, the province ought to attract doctoral graduates from institutions beyond Northeast China to join Liaoning's universities, thereby enhancing the openness of the regional academic labor market.

For local universities, government funding serves as the primary financial source, while performance evaluation remains pivotal for discipline development. Liaoning Province should rationally assess the organizational effectiveness of first-class discipline development, scientifically evaluate institutional strategies and team contributions, and improve fund utilization efficiency. To ensure openness and diversity in first-class discipline development, the government should establish a dynamic talent monitoring mechanism and incorporate the metrics of academic affiliation structure optimization into performance evaluations.

Universities should refine faculty recruitment processes by implementing "outbreeding-preference" hiring policies, breaking the inertia of "academic affiliation elitism," and avoiding the formation of closed academic mentorship loops. Through interregional institutional collaboration, Liaoning's universities must actively recruit academic talent from beyond Northeast

China, increase disciplinary diversity in academic affiliation, foster knowledge intersection and integration, broaden disciplinary perspectives, and ultimately enhance the overall quality of discipline development.

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Conflict of Interests

The authors declare that there is no conflict of interest regarding the publication of this paper.

Reference

[1] Liaoning Provincial People's Government. Notice on issuing the "Implementation Plan for Coordinated Advancement of World-Class Universities and Disciplines in Liaoning Province" [EB/OL]. (2017-01-03)[2025-08-08]. https://www.ln.gov.cn/web/zwgkx/lnsrmzfgb/2017n/qk/2017n_dsq45/szfwj/C79C4A28004A45B7B7E20CD3C1F92EAD/index.shtml

[2] Liaoning Provincial Department of Education. Notice on announcing the dynamic adjustment results of first-class discipline construction projects in Liaoning higher education institutions [EB/OL]. (2018-03-05)[2025-08-08]. http://xkb.dlut.edu.cn/info/1020/2122.htm

[3] General Office of Liaoning Provincial People's Government. Notice on issuing the "14th Five-Year Plan for Education Development in Liaoning Province" [EB/OL]. (2021-12-27)[2025-08-08]. https://www.ln.gov.cn/web/zwgkx/lnsrmzfgb/2022n/qk/2022n_dsq32/szfbgtwj/617AB182218A4841A16F88D1B0602AAE/

[4] Li, C. L., & Deng, H. Y. (2019). Quantitative Analysis of "Double First-Class" Policies in Chinese Provinces. Research in Higher Education of Engineering, (4), 145-151.

[5] Jung, J., & Horta, H. (2013). Higher education research in Asia: A publication and co-publication analysis. Higher Education Quarterly, 67(4), 398-419.

[6] Leydesdorff, L., & Wagner, C. S. (2008). International collaboration in science and the formation of a core group. Journal of Informetrics, 2(4), 317-325.

[7] Li, E. Y., Liao, C. H., & Yen, H. R. (2013). Co-authorship networks and research impact: A social capital perspective. Research Policy, 42(9), 1515-1530.

[8] Rigby, J., & Edler, J. (2005). Peering inside research networks: Some observations on the effect of the intensity of collaboration on the variability of research quality. Research Policy, 34(6), 784-794.

[9] Wagner, C. S., & Leydesdorff, L. (2005). Network structure, self-organization, and the growth of international collaboration in science. Research Policy, 34(10), 1608-1618.

[10] Cai, M. S., & Li, B. B. (2014). Using Game Theory to Analyzes Academic"Inbreeding"and Its Enlightenment. Journal of Educational Science of Hunan Normal University, 13(6), 116-120.

[11] Chen, X. Y., & Zhang, C. L. (2021). On the Academic Labor Market Prestige and Impact of Double First-class Universities. Journal of Higher Education, 42(5), 62-73.

[12] Chu, Z. F. (2017). Promoting Strategies and Reflection of World-class Universities and Discipline in Local Government--Based on 24 local "double world-class" policies texts. China Higher Education Research, (8), 50-55+67.

[13] Liu, X. (2020). Existence, Timeliness and Rationality?. Higher Education Exploration, (12), 98-109.

[14] Li, L. P., Shen, W. Q., & Zhao, F. Q. (2019). The Structure of Teachers' Educational Background in Elite Universities and Its Ten-year Transition——In the Case of Chemistry. Education Research Monthly, (10), 78-83.

[15] Barnett, G. A., Danowski, J. A., Feeley, T. H., et al. (2010). Measuring quality in communication doctoral education using network analysis of faculty hiring patterns. Journal of Communication, 60(2), 388-411.

[16] Fang, B. Y., & Zhang, D. S. (2002). Strengthening Postdoctoral Programs and Improve the Academic Affiliation Structure of Faculty. Research in Higher Education of Engineering, (2), 40-42.

[17] Liu, X., & Yan, F. Q. (2021). The Academic Origin, Appointment Network and Research Production of Full-time College Teachers among 28 Public Universities in China. Research in Educational Development, 41(23), 65-76.

[18] Yang, G., Yue, Y., & Niu, M. (2015). An empirical study of faculty mobility in China. Higher Education, 69(4), 527-546.

[19] Liu, J., Lin, S. Y., Wang, Y. M., et al. (2021). Can Research-Oriented University Faculties be Admitted to the University Where They Teach: Discussions on Academic Inbreeding in Colleges and Universities. China Higher Education Research, (8), 56-62.

[20] Jiang, H., Yang, S. D., Li, S., et al. (2023). Discipline Reputation Evaluation Based on PhD Exchange Network. Research in Higher Education of Engineering, (5), 117-123+157.

[21] Liu, L. (2019). Does Academic Inbreeding Inhibit Academic Productivity: A Case Study Based on H Discipline in a East and a West "Double First-Class" Construction Universities. China Higher Education Research, (12), 76-83.

[22] Sheng, Y. L. (2008). Structural Changes in Academic Qualification and Origin of Alma Mater of Tsinghua Faculty. Tsinghua Journal of Education, (2), 92-98+103.

[23] Xu, Z. P., & Liu, Y. (2018). Hierarchical Structure of Academic Labor Market. Higher Education Exploration, (3), 109-115.

[24] Burris, V. (2004). The academic caste system: prestige hierarchies in PhD exchange networks. American Sociological Review, 69(2), 239-264.

[25] Li, L. P., & Shen, W. Q. (2019). The Doctoral Employment Network of Chinese Elite Universities: The Analysis of Academic Labor Market Based on Chemistry. China Higher Education Research, (11), 83-89.

[26] Zhang, B. (2013). Departmental Stratification and Its Hierarchical Characteristics in the Ph.D.Exchange Network——A Social Network Analysis Based on Academic Structure of Part of Physics Scholars. Educational Research, 34(01), 84-90+96.

[27] Wang, T. L., & Wang, X. N. (2021). Network Analysis of Two-way Faculty Employment in Elite Business Schools of USA. Heilongjiang Higher Education Research, 39(08), 57-63.

[28] Han, S.-K. (2003). Tribal regimes in academia: A comparative analysis of market structure across disciplines. Social Networks, 25(3), 251-280.

[29] Hagstrom, W. O. (1971). Inputs, outputs, and the prestige of university science departments. Sociology of Education, 44, 375-397.

[30] Fairweather, J. S. (1988). Reputational quality of academic programs: The institutional halo. Research in Higher Education, 28(4), 345-355.

[31] Cowan, R., & Rossello, G. (2018). Emergent structures in faculty hiring networks, and the effects of mobility on academic performance. Scientometrics, 117(1), 527-562.

[32] Huang, J. X., Lu, X. M. (2011). Three Key Characteristics and Optimization of the Academic Affiliation Structure of University Faculty. Jiangsu Higher Education, (5), 41-43.

[33] Dong, Z. F., Huang, Y., & Huang, J. X. (2012). On Problems and Optimizing Countermeasures of the Teaching Body Academic Origin Structure in Chinese HEIs——Based on the Three Perspectives of Survey and Analysis. Education Science, 28(5), 48-52.

[34] Gu, H. B., & Zhu, Y. W. (2015). Analysis of Faculty Inbreeding between Chinese and Other Countries' Higher Education Institution in Department of Economics. China Higher Education Research, (3), 48-51.

[35] Chen, P., & Tian, L. (2015). The Study on the Structural Characteristics of Institutional Research Co-author Network in China——Based on the Statistical Analysis of 49 Educational Journals in CSSCI Catalogues in 10 years (2005—2014). China Higher Education Research, (11), 36-42+48.