Technical Cooperation or Hub-and-Spoke? Examining the Strategic Alignment Structure of the ISO Cooperation Network

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1 Background and Theory

2 Research Design

3 Measures and Results

4 Conclusion

Background

- International Organization for Standardization (ISO) is one of the largest and most comprehensive voluntary bodies for industrial standard-setting, encompassing hundreds of Technical Committees (TCs) across a wide range of sectors.

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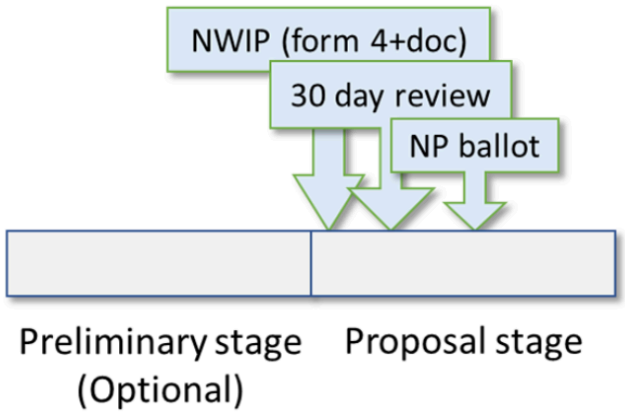
- Key principles in ISO standard development:
  - Respond to a need in the market
  - Based on global expert opinion
  - Developed through a multi-stakeholder process
  - Based on a consensus

Research Question

- Does ISO function primarily as a technical forum for cooperation, or does it reflect **hub-and-spoke structures** in which a handful of states exercise outsized influence?

Stages of Developing an ISO Standard

- ISO follows a consensus-based process with six stages:
  1. Proposal (NWIP): New project proposed; members approve.
  2. Preparatory (WD): WG drafts and refines text.
  3. Committee (CD): Circulated for comments; revised.
  4. Enquiry (DIS): All members vote (2/3 majority, <25% negative).
  5. Approval (FDIS): Final vote before adoption.
  6. Publication: Secretariat publishes the standard.



China's ISO Participation Strategy

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    - 2015 to 2018, Zhang Xiaogang served as the first Chinese President of ISO —> numbers of participation in TCs, subcommittees (SCs), and secretariat positions holding increases
    - Standardization now serves multiple goals: strengthening state-owned enterprises, reducing patent licensing costs, and projecting influence by promoting a "China model" that resonates with developing countries.

Our Network Perspective

ISO is not simply as a site of technical collaboration but as a **relational structur**e where influence may emerge from network embeddedness as much as from formal authority.

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Network Data and Methods

- Conceptualize ISO as cooperation network
- 17 sectors, 349 technical committees (Note: One TC can cover multiple sectors, overlapped with other TCs)
- Network measures: density, clustering , centrality, degree inequality, and community detection

Network Data

Committee	Title	Sector	Notes	SECRETARIA	participating members list
ISO/IEC JTC 1	Information t	9		ANSI	Australia Austria Belarus Belgium Brazil Canada China Côte d'Ivoire Denmark Ecuador Finland France Germany India Indonesia Iran, Islamic Republic of Ireland Italy Japan Kazakhstan Korea, Republic of Lebanon Luxembourg Malaysia Malta

A	B	C	D	E	F	V	W
Committee	Title	Sector	Notes	SECRETARIA	secretariat_(	node_a	node_b
ISO/IEC JTC 1	Information technology	9		ANSI	United State:	Australia	Austria
ISO/IEC JTC 1	Information technology	9		ANSI	United State:	Australia	Belarus
ISO/IEC JTC 1	Information technology	9		ANSI	United State:	Australia	Belgium
ISO/IEC JTC 1	Information technology	9		ANSI	United State:	Australia	Brazil
ISO/IEC JTC 1	Information technology	9		ANSI	United State:	Australia	Canada
ISO/IEC JTC 1	Information technology	9		ANSI	United State:	Australia	China
ISO/IEC JTC 1	Information technology	9		ANSI	United State:	Australia	C√¥te d'Ivoir
ISO/IEC JTC 1	Information technology	9		ANSI	United State:	Australia	Denmark
ISO/IEC JTC 1	Information technology	9		ANSI	United State:	Australia	Ecuador
ISO/IEC JTC 1	Information technology	9		ANSI	United State:	Australia	Finland
ISO/IEC JTC 1	Information technology	9		ANSI	United State:	Australia	France
ISO/IEC JTC 1	Information technology	9		ANSI	United State:	Australia	Germany

ISO Sectors

Table 1: *ISO Sectors*

Sector	Name
1	Food and Agriculture
2	Chemicals
3	Building and Construction
4	Business Management and Innovation
5	Energy
6	Sustainability and Environment
7	Health, Medicine and Laboratory Equipment
8	Horizontal Subjects
9	Information Technology, Graphics and Photography
10	Mechanical Engineering
11	Non-Metallic Materials
12	Ores and Metals
13	Freight, Package and Distribution
14	Security, Safety and Risk
15	Services
16	Special Technologies
17	Transport

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Density

Network density captures the overall level of connectedness in the system. It is defined as the ratio of observed ties to all possible ties:

$$Density = \frac{2m}{n(n-1)}, \tag{1}$$

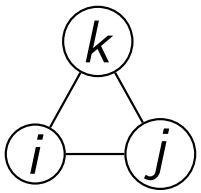
where m is the number of observed edges and n is the total number of nodes. Density ranges from 0 to 1, with higher values indicating a more cohesive network in which states are more broadly connected.

Clustering Coefficient

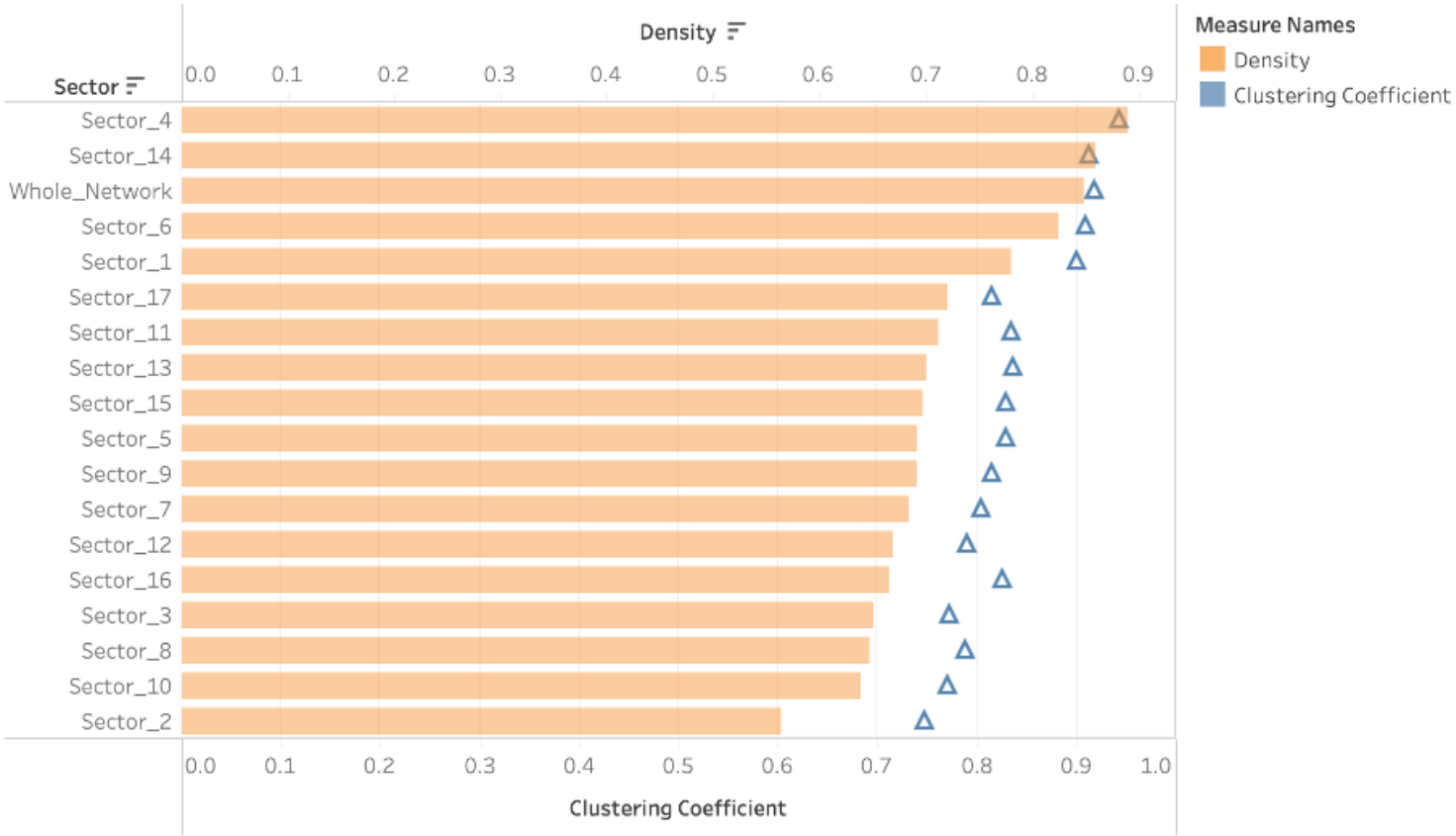
Clustering, by contrast, captures the tendency of the network to form tightly connected groups through triadic closure. The global clustering coefficient summarizes this property at the system level and is defined as the average of the local clustering coefficients across all nodes:

$$C = \frac{1}{n} \sum_{i=1}^{n} C_i, \tag{2}$$

where C_i is the local clustering coefficient of node i, measuring the proportion of ties that exist among its neighbors. **Higher values indicate the presence of cohesive subgroups or coalition-like structures within ISO.**



Result

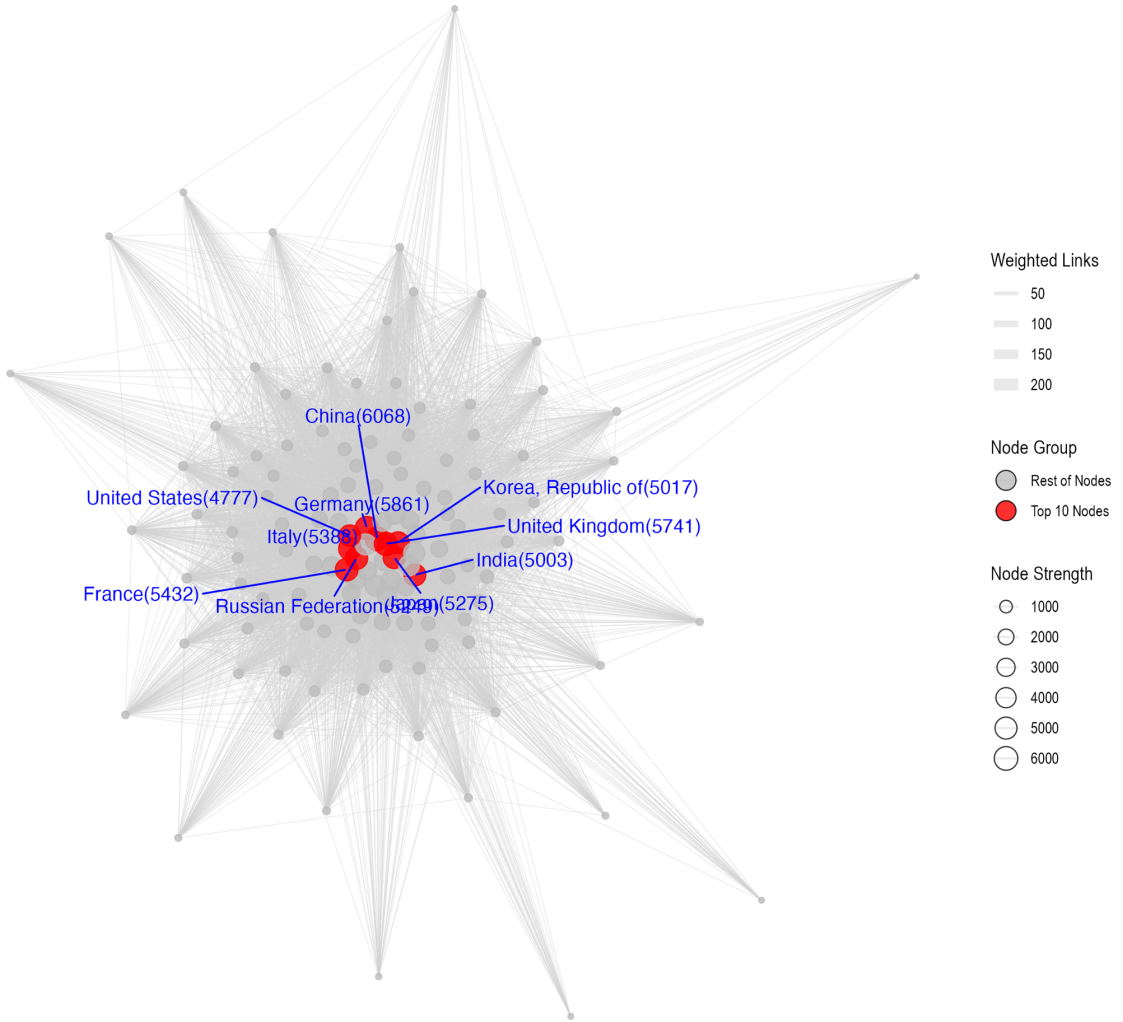

Density
Sector
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9
Sector_4
Sector_14
Whole_Network
Sector_6
Sector_1
Sector_17
Sector_11
Sector_13
Sector_15
Sector_5
Sector_9
Sector_7
Sector_12
Sector_16
Sector_3
Sector_8
Sector_10
Sector_2
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Clustering Coefficient
Measure Names
Density
Clustering Coefficient

Network Centrality: Popularity and Privilege

Degree centrality measures how many direct connections a state has within the network (Freeman 1979). In an undirected network such as ISO, the degree of a node is defined as the number of other nodes to which it is directly connected, calculated as:

$$D(i) = \deg(i) = \sum_{j=1}^{n} a_{ij}, \tag{3}$$

Results


China(6068)
United States(4777)
Germany(5861)
Korea, Republic of(5017)
United Kingdom(5741)
Italy(5388)
India(5003)
France(5432)
Russian Federation(5249)
Japan(5275)
Weighted Links
50
100
150
200
Node Group
Rest of Nodes
Top 10 Nodes
Node Strength
1000
2000
3000
4000
5000
6000

Results

State	Total
China	6,068
France	5,432
Germany	5,861
India	5,003
Italy	5,388
Japan	5,275
Korea	5,017
Russia	5,249
UK	5,741
USA	4,777

Sector	China	France	Germany	India	Italy	Japan	Russia	Korea	UK	USA
S1	1	6	1	4	5		3		7	
S2	1	5	3	7	6			1	4	
S3	1	6	4			1	1	8	5	7
S4	1	8	5	6	2		7	4	3	
S5	1	4	3	7	2		6	8	5	
S6	1	3	4	1	8	6		5	6	
S7	1		1		5	3		7	4	6
S8	1	1	1		7	8	4		4	4
S9	4	7	3	8	2	4			1	6
S10	1	3	1		5	5	8	9	4	7
S11	1	7	2	4	5		6		2	8
S12	1	5	4	7	3	2	8		6	
S13	1	1	1	8	4	7	6	9	5	
S14	1		5	1	1	4	5			
S15	1	9	6	5	7	8	3	4	2	
S16	2	7	4	10	8	6	1	4	2	9
S17	1	1	1		8	7	1	6	1	

Color
100 748

Size
108
400
600
748

Figure 1: *Degree rankings of the top 10 ISO member states across all 17 sectors. The figure illustrates that China consistently ranks at the top in nearly every sector.*

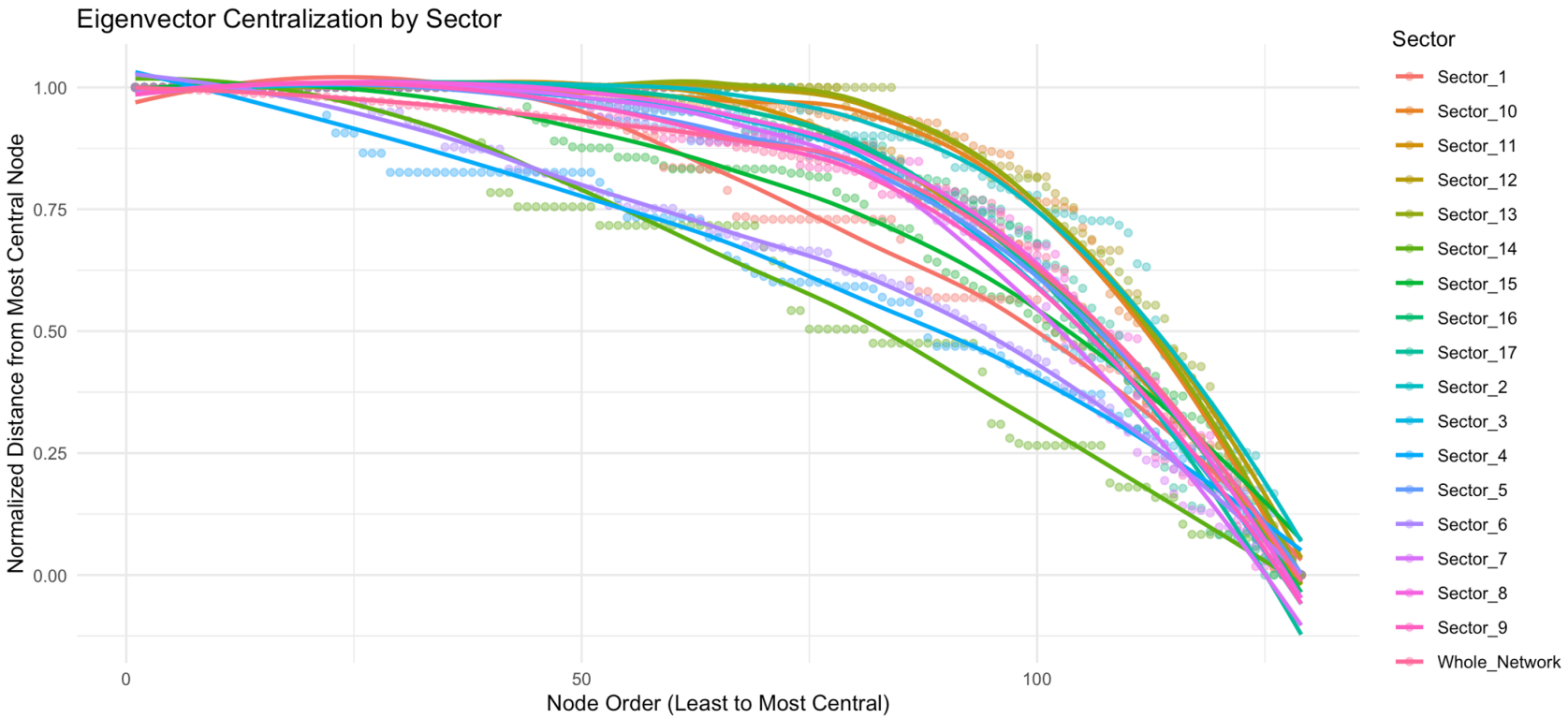
Eigenvector Centrality

The eigenvector centrality of node i is defined as the i-th entry of the eigenvector associated with the largest eigenvalue of A. Equivalently, the centrality of a node is proportional to the summed centralities of its neighbors:

$$E(i) = \frac{1}{\lambda} \sum_{j=1}^{n} a_{ij} E(j), \tag{4}$$

where a_{ij} is the adjacency matrix entry between nodes i and j, and λ is the largest eigenvalue of A. This formulation captures how influence can cascade through the network: a state connected to influential partners is itself more influential.

Results


Eigenvector Centralization by Sector
Normalized Distance from Most Central Node
1.00
0.75
0.50
0.25
0.00
0
50
100
Node Order (Least to Most Central)
Sector
Sector_1
Sector_10
Sector_11
Sector_12
Sector_13
Sector_14
Sector_15
Sector_16
Sector_17
Sector_2
Sector_3
Sector_4
Sector_5
Sector_6
Sector_7
Sector_8
Sector_9
Whole_Network

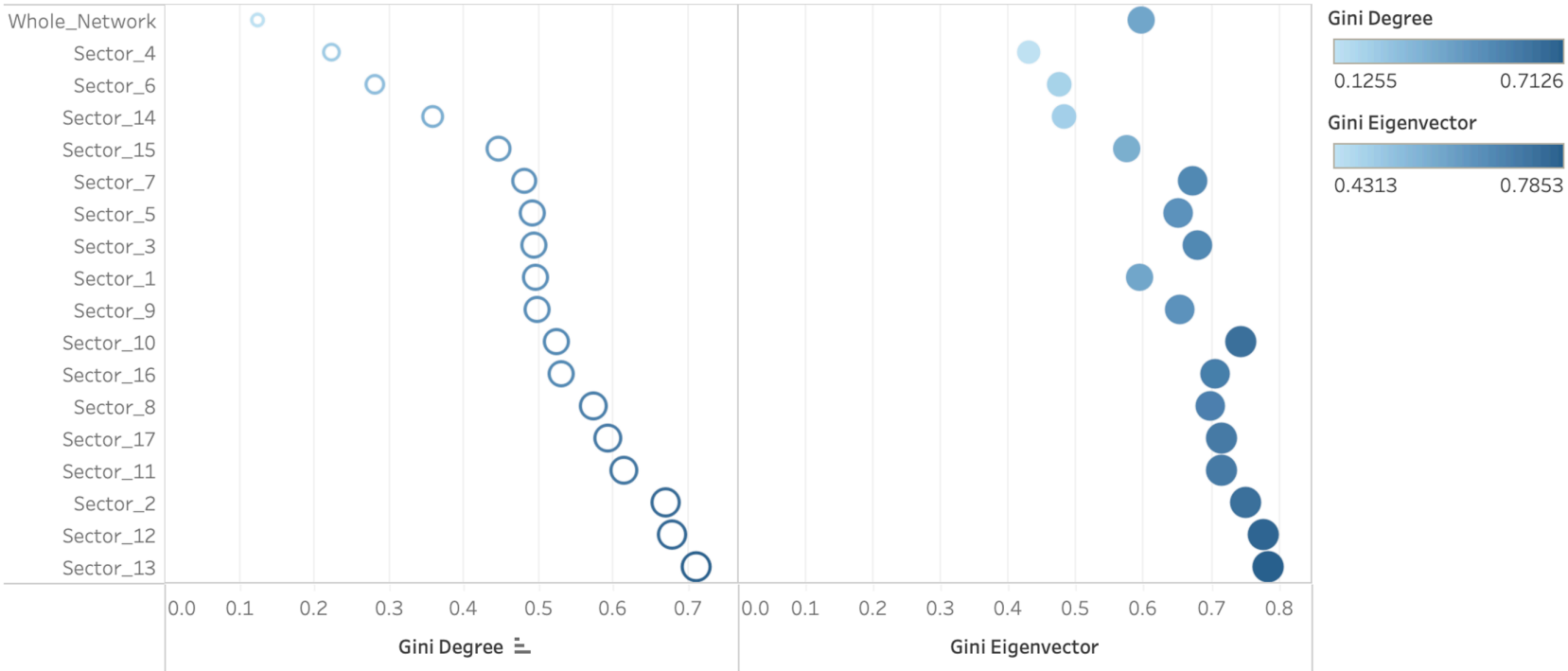
Imbalanced Connection

To further investigate the selective nature of cooperation in the ISO network, we examine both popularity (degree centrality) and privilege (eigenvector centrality) through their distributional inequality.

$$G_D = \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} |D(i) - D(j)|}{2n \sum_{i=1}^{n} D(i)}, \tag{5}$$

$$G_E = \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} |E(i) - E(j)|}{2n \sum_{i=1}^{n} E(i)}, \tag{6}$$

Results


Whole_Network
Sector_4
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Sector_11
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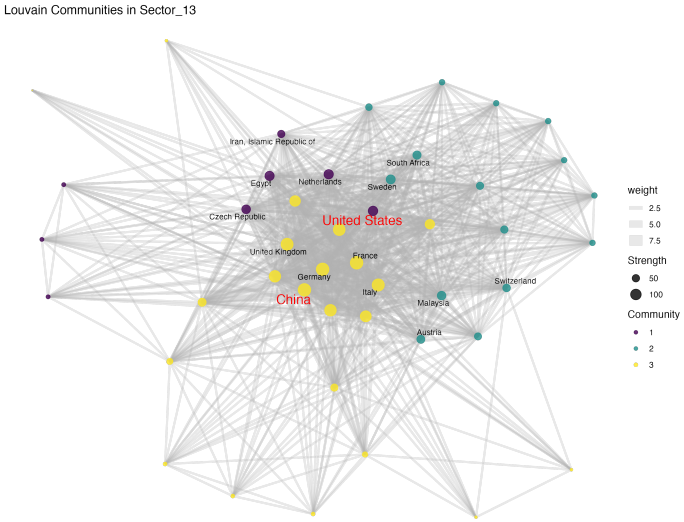
Sector_12
Sector_13
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7
Gini Degree
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
Gini Eigenvector
Gini Degree
0.1255 0.7126
Gini Eigenvector
0.4313 0.7853

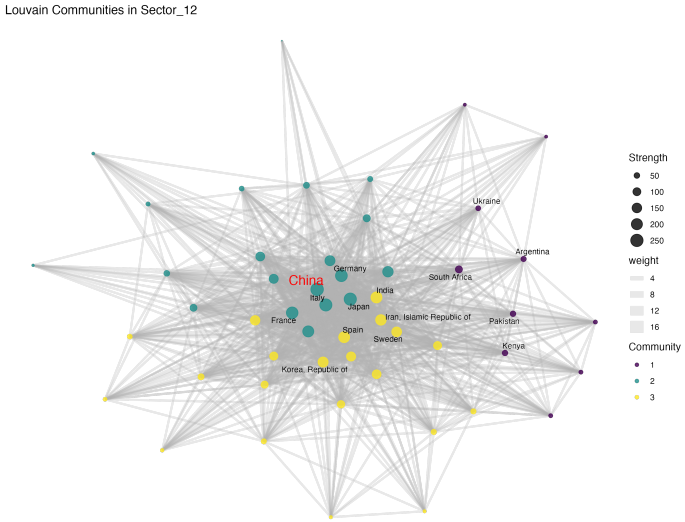
Community Detection

Louvain method assumes that states cluster into cooperation blocs when they share denser ties with each other than with the broader membership (Blondel et al. 2008; Traag et al. 2019).
This means that ISO's cooperation structure is not treated as random overlap but as reflecting underlying patterns of selective alignment: states are more likely to cooperate repeatedly within certain groups, forming cohesive coalitions.

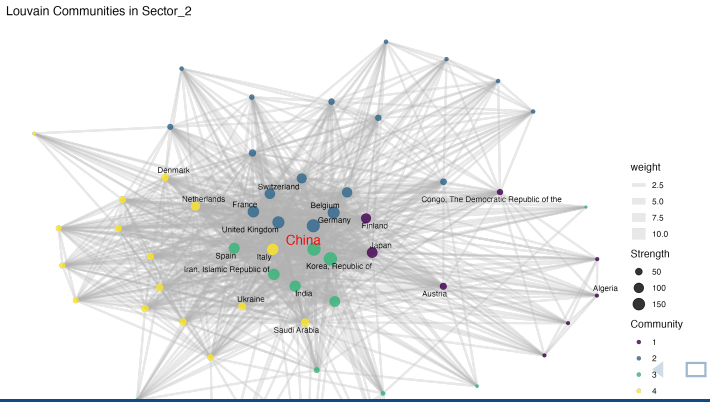
Results: Top 3 Most imbalanced Communities



(a) Sector 13: Freight, Package and Distribution



(b) Sector 12: Ores and Metals



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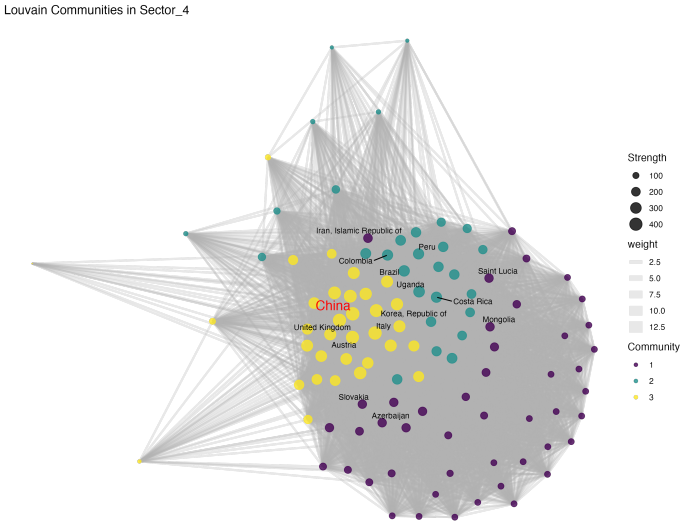
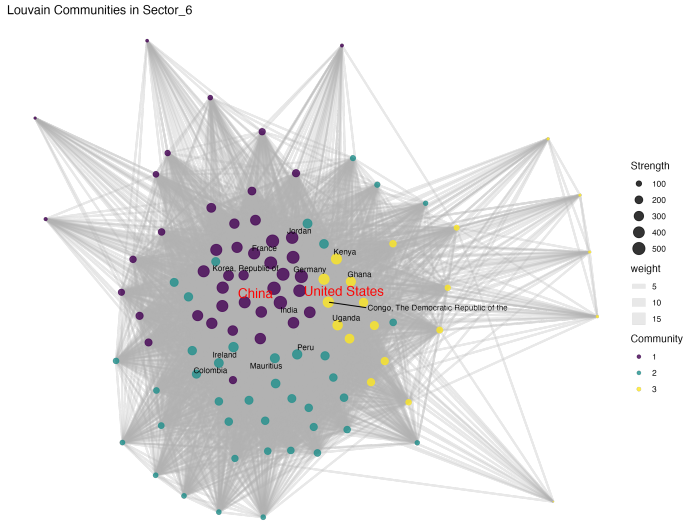
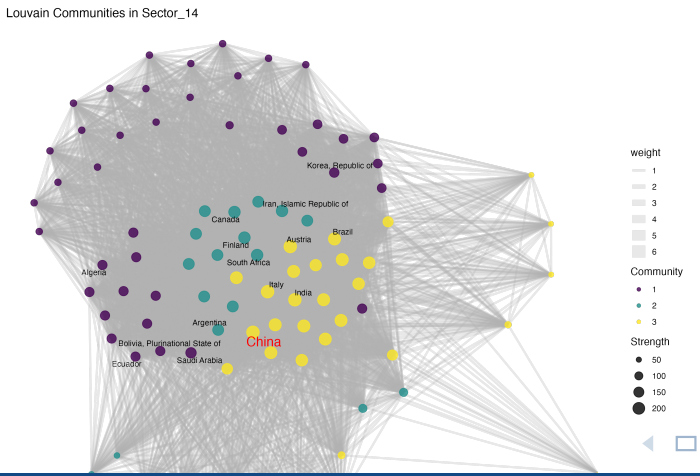


(a) Sector 4: Business Management and Innovation



(b) Sector 6: Sustainability and Environment



US-China Leading Communities

Sector	Name	Country	Group	Degree
1	Food and Agriculture	China	2	74
2	Chemicals	China	3	55
3	Building and Construction	China	3	81
4	Business Management and Innovation	China	3	107
5	Energy	China	1	79
6	Sustainability and Environment	China	1	103
		United States	3	101
7	Health, Medicine and Laboratory Equipment	China	3	82
8	Horizontal Subjects	China	1	66
9	Information Technology, Graphics and Photography	United States	3	78
10	Mechanical Engineering	China	2	77
11	Non-Metallic Materials	China	1	59
12	Ores and Metals	China	1	50
13	Freight, Package and Distribution	China	1	44
		United States	2	36
14	Security, Safety and Risk	China	3	90
15	Services	China	2	85
16	Special Technologies	China	3	62
17	Transport	China	2	62

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Conclusion and Future Direction

- ISO is not simply a forum for technical cooperation. It is a networked structure where technical collaboration coexists with strategic alignment.
- Limitation: The Sector–TC network shows China's systemic centrality, but not genuine **influence**. It captures "activeness" —broad participation across TCs/sectors. China's dominance is echoing literature on its strategic ISO participation.

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Thank You!