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# The International Power Structure System in South Asia and Its Operational Mechanisms Based on Social Network Analysis(SNA)

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# The International Power Structure System in South Asia and Its Operational Mechanisms Based on Social Network Analysis(SNA)

Abstract: This paper employs SNA to systematically examine the international power system in South Asia and its operational mechanisms. Through quantitative analysis of seven South Asian nations—India, Pakistan, Nepal, Bhutan, Sri Lanka, Maldives, and Bangladesh—along with China as a key external node, a multi-dimensional relational network model encompassing economic, military, geographic, and ideological dimensions was constructed. Findings reveal a pronounced core-periphery structure in South Asia, with India occupying a dominant core position in the economic network and a structurally leading position in the military network, while Pakistan functions as a secondary hub. Intra-regional states exhibit tight economic interdependence but sparse military ties, and external power intervention further drives the evolution toward a multipolar power structure. The study also reveals the pathways of power diffusion, alliance balancing mechanisms, and the contradictory characteristics of economic dependence versus military independence within South Asia. It provides an analytical framework combining theoretical explanation and empirical support for understanding the complex dynamics of South Asian international relations.

Keywords: SNA, South Asia region, international power structure, core-periphery structure

## 1 Introduction

South Asia occupies a pivotal position on the Eurasian continent, holding significant geopolitical and economic importance in global international relations. Comprising multiple nations including India, Pakistan, Nepal, Bhutan, Sri Lanka, the Maldives, and Bangladesh, the region possesses a unique historical and cultural backdrop while confronting complex geopolitical challenges. Following the end of the Cold War, the deepening of globalization has precipitated profound shifts in South Asia's power structure. India has gradually established its dominant position in the region through rapidly growing economic and military strength. However, the influence of other regional and extra-regional actors—such as China and the United States—cannot be overlooked. Within this multi-layered, multi-centered landscape, the intertwined political, economic, and military relationships among nations form South Asia's unique international power structure. Deeply examining this power structure and clarifying the dynamics of power interactions both within and beyond the region holds significant implications for formulating China's diplomatic strategy in South Asia.

Against this backdrop, traditional international relations analytical approaches show limitations, as they often focus on the internal characteristics of individual states while

overlooking inter-state connections. In recent years, SNA has emerged as an effective method for studying international power structures. By quantifying the strength of inter-state relationships, centrality, and dependency, this approach can more clearly reveal the complex interactions within South Asia's power structure. This paper employs SNA, integrating multidimensional data encompassing economic, military, geographic, and ideological dimensions, to construct a realistic model of South Asia's international power structure and dissect its operational mechanisms. By examining the power characteristics of regional states and their interdependent relationships, this study aims to reveal the core-periphery structure and power distribution dynamics within South Asian international relations.

## 2 Research Methods and Data Sources

### 2.1 Theoretical Framework and Research Methods

#### 2.1.1 Geopolitics and Power Distribution

Many geopolitical scholars emphasize that power is fundamentally a relational concept and should be understood as a relative existence. For instance, Dahl defines power as the ability to induce others to do what they would not otherwise do.[1] Morgenthau's classic realist theory posits that power constitutes control over other actors.[2] Baldwin explicitly stressed that power is a relational concept, referring to the relationship between two or more actors rather than an attribute of any single one.[3] Lasswell and Kaplan similarly defined power as a relational quality rather than a simple attribute.[4] Taking the Cold War era as an example, one perspective viewed power as a zero-sum game, arguing that any increase in Soviet power corresponded to a corresponding decrease in American power. Today, this relativity of power is increasingly treated as a quantitative issue. For instance, in studies of dyadic conflict, the variable of power balance is often operationalized as the power differential between two actors. However, such research methods frequently overlook information originating outside the two actors, subjectively treating dyadic interactions as closed systems rather than considering them within broader international relations networks. Cartwright proposed that if Actor A can induce a certain change in Actor B through its actions, this indicates A can influence B. Furthermore, if A possesses the capacity to influence B, then A holds power over B.[5] In other words, he argued that power exists within specific bilateral relationships. In reality, however, state power is not an isolated concept but is intrinsically linked to other system members and the architecture of the international system. Defining a state's power solely based on its own resources and isolating it from other states within the system leads to a measurement approach that disregards the

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[1] Dahl RA.Further reflections on the elitist theory of democracy. American Political Science Review[J]. 1966, 60(2): 296–305.

[2] Morgenthau H J, Thompson K W, Clinton W D. Politics among nations: The struggle for power and peace[J]. 1985, 8(4): 517–560.

[3] Baldwin DA. Economic Statecraft. Princeton[M]. NJ: Princeton University Press, 1985, pp. 18-24.

[4] Lasswell H D, Kaplan A. Power and society: A framework for political inquiry[M]. Transaction Publishers, 2013.

[5] Cartwright D. Influence, leadership, control. In: March J (ed.) *Handbook of Organizations*[M]. Chicago: Rand McNally, 1965, pp. 1–47.

status of other system members. Consequently, such quantitative assessments become disconnected from the actual international power structure.

The architecture of the international system and the distribution of power among states exhibit a bidirectional relationship.[6] The characteristics of state power shape the international system's architecture, while the system's architecture in turn constrains and influences the form and attributes of state power. However, most traditional methods for quantifying state power struggle to effectively capture this interaction between system architecture and power distribution. To achieve this goal, state power must be quantified within networked relational contexts. This necessitates establishing a power perspective grounded in social network theory. This perspective posits that a state's power does not stem from its own resources but depends on its linkage and interaction patterns with other system members within relational networks. Traditional power concepts evaluate state power based on the attributes of its internal resources. In contrast, the social network power concept assesses state power based on its interactions with other members within the system.

### 2.1.2 Framework Construction Under the Social Network Analysis Paradigm

SNA, as a method for analyzing relational structures, is capable of measuring the characteristics of persistent relationship patterns among nodes within a social network. This includes the definition of nodes, the modes of constraint, and the inter-influence relationships, thereby providing theoretical and instrumental support for international relations scholars in identifying and quantifying network structures. The relational data used in this analysis originates from the practice of international relations. After extraction and processing, it can link social relational structures to specific outcomes, thereby revealing the morphology of the overall network structure of a group.

In international relations, network structures are often viewed as a distinct organizational pattern.[7] They differ from both the hierarchical systems of states and formal international organizations, and the transient and volatile supply-demand relationships of the international market.[8] SNA offers a more comprehensive perspective for understanding interstate relations, aiding in answering key questions such as how military alliances alter a state's propensity for conflict, or the motivations behind a state's accession to various international organizations or agreements. This methodology serves as a valuable supplement to traditional structural research in international relations. Traditional studies tend to focus on the attributes of actors and static equilibria, whereas SNA concentrates on how material and social relations among states form balanced structures through dynamic processes. It can describe the operational mechanisms of processes like alignment and neutralization, and provide methods for measuring these structures, thereby opening new avenues for re-examining core issues such as the international power structure.

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[6] Waltz KN. Theory of International Politics[M]. New York: Random House, 1979.
[7] 刘从德：《地缘政治学导论》，北京：中国人民大学出版社，2010 年，第 50-53 页。
[8] 刘大庆、白玲、张宏等：《全球地缘政治格局演变的动力机制——基于变量与变量关系的解析》，载《地理研究》，2018 年第 37 期第 2 卷，第 391-403 页。

（1）Composition of a Social Network

A social network is constituted by nodes and the association patterns connecting these nodes. Nodes can be actors such as individuals, organizations, or states, representing their structural position within the network. Association patterns are the channels linking nodes, encompassing both the flow of material entities like weapons, capital, and goods, and the transmission of non-material elements such as information, ideas, trade relations, or diplomatic ties. These association patterns determine whether and to what intensity connections can arise between actors. In international relations research, association patterns are used to define the interactive states of countries within a group network, and to characterize the relationships between individual states and collective actors like alliances or interest groups. For the analysis of the international power structure in the South Asia region, nodes correspond to the South Asian countries, while association patterns can include geopolitical relations, geographical distance, trade flows, and so on.

（2）SNA Framework

Within SNA, a network is defined as any set or multiple sets of relationships among any one or more groups of nodes.[9] Unlike traditional relational studies, SNA does not make a priori assumptions about the homogeneity of nodes or association patterns, thereby enabling the analysis of any type of connection. Precisely because of this, the method allows for the calculation and visualization of the structural characteristics of nodes, subgroups, or the entire network. It can subsequently predict node behavior and investigate the influence of network structure on participant actions.

After clarifying the nodes and association patterns within the international power structure network of the South Asia region, this study can construct a corresponding SNA framework.[10] The construction of this framework primarily involves the following steps (see Figure 1): First, determine the type of SNA. South Asian countries exist both within the global international system as a whole network and constitute their own ego-centered networks within the South Asian sub-region. Whole network research focuses on the international system network itself, while ego-centered networks concentrate on each node and its immediate connections. Therefore, it is first necessary to clarify the network type emphasized in this study. Second, based on international relations theory, define the nature of relationships within the international power structure network of the South Asia region. As this study focuses on the power structure, the core of this step is to analyze the complex power relations formed by the positions of various countries within the network. Third, collect social network relational data related to the international power structure of the South Asia region through multiple channels. Describing regional international relations often employs indicators such as economic and trade flow data, military dispute records, and voting cohesion within international organizations.[11] Fourth, based on the relational data,

[9] 林聚任：《社会网络分析:理论、方法与应用》，北京师范大学出版社，2009 年。
[10] Wasserman S, Faust K. Social Network Analysis: Social Network Analysis in the Social and Behavioral Sciences[M]. Cambridge University Press, 1994.
[11] Jackson P T, Nexon D H. Relations Before States: Substance, Process and the Study of World Politics[J]. European

measure the various relationships constituting the international power structure of the South Asia region. Fifth, conduct specific analysis of the social network relational data. Sixth, based on the data analysis results, describe the specific relationships and draw descriptive inferences. Seventh, utilize matrices, sociograms, and other methods to visually represent the social network relational data of the South Asia region's international power structure.

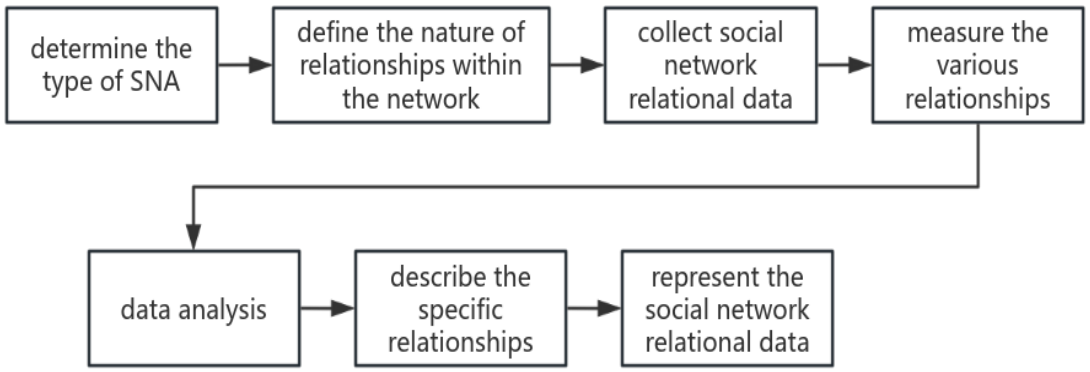



Figure 1 Steps of SNA

### 2.1.3 Research Methodology

A key focus of SNA lies in identifying the critical parameters used to measure network structure. These primarily include centrality, influence index, correlation index, and cohesion index.[12] This study selects the aforementioned parameters to analyze the overall characteristics, structural features, power distribution, and dependency relationships within the social network of the international power structure in the South Asia region.

（1）Centrality

A key objective in applying SNA is to explore the distribution of power among individuals or organizations within their respective networks—that is, to assess their power status.[13] Centrality serves as the core metric for characterizing a node's power within a network, commonly measured through degree centrality, betweenness centrality, and closeness centrality.

Degree Centrality describes the local centrality index of an actor within a social network. It measures an actor's transactional capacity with other actors, without considering whether the actor possesses the ability to control others.[14] Numerically, this parameter equals the total number of relationships connecting that node to other nodes in the network (see Equation 1). A higher value indicates that the node is connected to a

Journal of International Relations, 2016, 5(3):291-332.

[12] 秦奇，吴良，李飞等：《基于社会网络分析的东南亚地缘关系研究》，载《地理学报》，2018 年第 73 期第 10 卷，第 2014-2030 页。

[13] Krivitsky P N, Handcock M S. Fitting Latent Cluster Models for Networks with latentnet[J]. Journal of Statal Software, 2007, 24(5), 1-23.

[14] Koschade, Stuart. A Social Network Analysis of Jemaah Islamiyah: The Applications to Counterterrorism and Intelligence[J]. Studies in Conflict and Terrorism, 2006, 29(6):559-575.

greater number of other nodes, meaning the actor represented by that node possesses greater transactional power within the social network. To characterize the degree centrality of the network more clearly, it is necessary to introduce standardized degree centrality to eliminate interference caused by the total number of nodes (see Equation 2). When studying the international power structure in South Asia, degree centrality alone is insufficient to comprehensively measure national power. It is also necessary to utilize group degree centrality to measure the concentration of power within alliances or groups (see Equation 3).

The magnitude of group degree centrality corresponds to the concentration of power within national alliances or groups in the international power structure of South Asia. For this study, the focus of this parameter is on several lower-tier countries within the region's international power structure. Where: $C_D(n_i)$ is the degree centrality of node $i$; $X_{ij}$ indicates whether a relationship exists between node $j$ and node $i$. If a relationship exists, $X_{ij}$=1; otherwise, $X_{ij}$=0; $C_D(n_{max})$ represents the maximum degree centrality among all nodes in the social network; $C_D(n_i^*)$ is the standardized degree centrality of node $i$; $g$ denotes the total number of nodes in the social network; $C_D$ represents the group degree centrality.

$$C_D(n_i) = d(n_i) = \sum_j X_{ij} = \sum_j X_{ji} \quad (1)$$

$$C_D(n_i^*) = \frac{d(n_i)}{g-1} \quad (2)$$

$$C_D = \frac{\sum_{i=1}^{g}[C_D(n_{\max}) - C_D(n_i)]}{\max \sum_{i=1}^{g}[C_D(n_{\max}) - C_D(n_i)]} \quad (3)$$

Betweenness Centrality describes an actor's capacity to control other actors, measuring how many connections within the network rely on that node. A higher betweenness centrality value indicates that the node controls more information flows in the network, thereby facilitating greater access to benefits. Similar to degree centrality, this parameter also requires the calculation of standardized values and group values (see Equations 4, 5, and 6). Where: $C_B(n_i)$ represents the betweenness centrality of node $i$; $g_{jk}$ denotes the number of geodesics (shortest paths) from node $j$ to node $i$; $C_B(n_{max})$ represents the maximum betweenness centrality among all nodes in the social network; $C_B(n_i^*)$ is the standardized betweenness centrality of node $i$; $g$ indicates the total number of nodes in the social network; $g_{jk}(n_i)$ indicates whether a geodesic from node $j$ to node $k$ passes through node $i$. If it does, the value is 1; otherwise, it is 0; $C_B$ represents the group betweenness centrality.

$$C_B(n_i) = \sum_{j<k} (g_{jk}(n_i)/g_{jk}) \quad (4)$$

$$C_B(n_i^*) = 2\frac{\sum_{j<k}(g_{jk}(n_i)/g_{jk})}{(g-1)(g-2)} \quad (5)$$

$$C_B = 2\frac{\sum_{i=1}^{g}[C_B(n_{\max}) - C_B(n_i)]}{(g-1)^2(g-2)} \quad (6)$$

Closeness centrality describes an actor's ability to operate free from the control of other actors and indicates the distance from a given node to all other nodes in the network. A higher value suggests that the actor represented by this node is less dependent on others within the relational network. It is calculated as the sum of geodesic distances between the node and all other nodes in the network (see Equation 7). Where: $C_{AP}(n_i)$ denotes the closeness centrality of node $i$; $d_{ij}$ represents the total geodesic distance from node $j$ to node $i$.

$$C_{AP}^{-1} = \sum_{i=1}^{g} d_{ij} \quad (7)$$

（2）Influence Index

Influence Index and the aforementioned centrality measures can both describe the power of nodes within a social network. Among them, the Influence Index reflects the overall contribution of a specific node to the network structure.[15] The value of this parameter is related to both the input and output volumes of the node within the network. Therefore, nodes with high influence, as measured by this index, inherently possess substantial both inward and outward flows within the network structure. In the study of social network structures in international relations, the Influence Index can be utilized to examine the degree of mutual influence among countries within a region.

（3）Correlation Index

To assess the level of cohesion among actors within a social network structure and analyze the closeness of connections between them, it is necessary to consider the Correlation Index.[16] The Correlation Index describes the hierarchy of relationships among actors in a social network and the efficiency of information transmission within the relational network. It is generally expressed through reachability (see Equation 8). Where: $C$ represents the Correlation Index; $n$ denotes the scale of the social network; $m$ indicates the number of pairs of nodes that are unreachable within the social network.

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[15] Maoz, Zeev. Network Polarization, Network Interdependence, and International Conflict, 1816-2000[J]. Journal of Peace Research, 2006, 43(4):391-411.

[16] 李艳杰：《杭州市 A 级景区群网络结构的关联性分析》，载《中国市场》，2018 年第 957 期第 2 卷，第 243-244 页。

$$C = 1 - [\frac{2m}{\text{n(n-1)}}]^{17} \quad (8)$$

（4）Cohesion Index

The Cohesion Index can describe the degree of power concentration within a social network structure. For the specific relational network region of South Asia, there exists a distinct number of independent pathways between each pair of actors. The Cohesion Index refers to the minimum number of such independent pathways within the network. From another perspective, the Cohesion Index of a social network corresponds to the minimum number of nodes that must be removed to render the interconnected network structure unreachable.

The specific operational steps are as follows: First, assume three ideal scenarios for the existence of central nodes. Then, employ SNA to investigate the mechanisms underlying collective contention at the lower levels of the international power structure in South Asia, deriving the characteristics and patterns of change in the region's international relations under these ideal conditions. Subsequently, based on the actual circumstances in South Asia, construct a more complex SNA model of the region's international power structure. To describe the overall characteristics of this realistic SNA model, utilize the parameter of network density to represent the closeness of relationships between each actor and the system as a whole. Additionally, employ network structural entropy to measure the internal orderliness of this social network model. Second, to study the internal structure of this social network model in greater detail, use the core-periphery structure index to describe its structural features. This will illustrate the tendencies of aggregation or detachment among nodes within the SNA model of South Asia's international power structure under the modern international order. Third, calculate parameters such as degree centrality, betweenness centrality, closeness centrality, influence index, correlation index, and cohesion index for the realistic social network model of the lower levels of South Asia's international power structure. These metrics will characterize the power dynamics of nodes within the model and measure the dependency relationships among actors. The purpose is to assess the collective nature of contention at the lower levels of South Asia's international power structure under the modern international order. Fourth, based on the power calculations for each node and the descriptions of dependency relationships, explore the formation mechanisms of these dependencies at the lower levels of South Asia's international power structure. Finally, drawing on the insights provided by the relevant parameters, investigate the specific mechanisms underlying collective contention at these lower levels.

## 2.2 Data Sources and Processing

### 2.2.1 Definition of Research Subjects

[17] 刘大庆、白玲、郗笃刚等：《全球地缘政治格局力量结构演变研究——基于社会网络分析法》，载《世界地理研究》，2018 年第 27 期第 1 卷，第 14 页。

This study identifies seven South Asian regional countries—India, Pakistan, Nepal, Bhutan, Sri Lanka, the Maldives, and Bangladesh—as the core subjects of analysis. Additionally, to examine how the power structure network in South Asia responds to and integrates external influences, it is necessary to introduce an external actor with significant and close ties as a key node. Given the extensive and profound historical, political, and economic connections between China and South Asian countries, this study selects China as the external key actor for inclusion in the analysis. By collecting case data related to China's participation in socio-economic development projects in South Asia, a more realistic social network model of the international power structure in the region—incorporating an external key node—can be constructed. Based on the key parameters of this model, the characteristics of the internal power dynamics and the dependency relationships among states within the South Asian region can be further analyzed.

### 2.2.2 Data Selection and Processing Methods

In this section, to build a scientifically grounded model that closely reflects the dynamics of the international power structure in South Asia, the strength of strategic relationships between nodes in the model will be quantified based on three dimensions: the military and economic power disparity between actors, geographical distance, and similarity in United Nations voting positions.

First, the weapon trade flow matrix in South Asia is constructed to measure the military power disparity among regional actors. Each cell value in the matrix is initially set as the ratio of the military expenditure of the column actor to that of the row actor. For cells with values less than 1, the reciprocal is taken to derive a matrix that reflects military power disparity. A cell value closer to 1 indicates a smaller military power gap between the two nodes, while a value farther from 1 indicates a larger gap. By taking the natural logarithm of each cell value, a standardized Weapon Trade Flow Matrix is obtained. The military expenditure data for each actor are sourced from the annual arms trade information provided by the Stockholm International Peace Research Institute.[18]

Second, the economic trade flow matrix in South Asia is constructed to assess the economic power disparities among regional actors. Each cell value in the matrix is initially set as the ratio of the GDP of the column actor to that of the row actor. For cells with values less than 1, the reciprocal is taken to generate a matrix that reflects economic power disparities. A cell value closer to 1 indicates a smaller economic power gap between the two nodes, while a value farther from 1 indicates a larger gap. By taking the natural logarithm of each cell value, a standardized Economic Trade Flow Matrix is obtained. The GDP data for each actor are sourced from the economic and trade information provided annually by the World Bank.[19]

Third, a geographic distance matrix is constructed based on the actual distances between countries in the region. Using the geographic distance data from the publicly

[18] Primarily based on the SIPRI Yearbook on Armaments, Disarmament, and International Security published annually; https://www.sipri.org/yearbook/translations.
[19] https://databank.worldbank.org/home.aspx.

available dataset of The Correlates of War Project,[20] distances between nodes in the constructed social network model are categorized as follows: If two nodes share a land border, the cell value in the geographic distance matrix is set to 1; If the distance between two nodes is less than 12 nautical miles, the cell value is set to 2; If the distance is greater than 12 nautical miles but less than 150 nautical miles, the cell value is set to 3; If the distance is greater than 150 nautical miles but less than 400 nautical miles, the cell value is set to 4; If the distance exceeds 400 nautical miles, the cell value is set to 5.

Fourth, an ideological difference matrix is constructed based on the similarity of United Nations voting patterns among countries in the region. Using the voting records of countries in the United Nations General Assembly from the publicly available dataset of the Dag Hammarskjöld Library,[21] ideological differences between nodes in the constructed social network model are categorized as follows: If the voting records of two actors are identical, the cell value is set to 0; If one actor abstains while the other votes in favor or against, the cell value is set to 0.5; If one actor's voting record is missing while the other votes in favor or against, the cell value is set to 0.5; If one actor abstains while the other's voting record is missing, the cell value is set to 1/3; If the voting records of both actors are missing, the cell value is set to 1. After setting the cell values, an Ideological Difference Weighted Matrix is constructed based on voting similarity. Voting similarity is calculated by subtracting the counts of the above cases from the total number of votes cast by each actor and then dividing the result by the total number of votes cast by the actor.

Fifth, to measure the centrality of collective contention at the lower levels of the South Asian international power structure, China's involvement in socio-economic development projects in South Asia is introduced to construct a real-world multilevel social network model of the region's international power structure. The power characteristics and dependency relationships in South Asia are analyzed based on the key parameters of this model. Using the matrix of China's participation in socio-economic development projects in each node from 2000 to 2019 as the baseline for setting cell values, the following categorization is applied: If the number of China's participation cases in a node's socio-economic development is 0, the cell value is set to 0; If the number of cases is greater than 0 but less than or equal to 3, the cell value is set to 1; If the number of cases is greater than 3 but less than or equal to 5, the cell value is set to 2; If the number of cases exceeds 5, the cell value is set to 3. Taking the matrix of China's participation in socio-economic development projects as the independent variable, and the regional Economic Trade Flow Matrix, Weapon Trade Flow Matrix,

[20] COW is committed to collecting, disseminating, and utilizing accurate and reliable quantitative data in international relations. Its key principles include standard scientific principles, the reliability of replicating and citing data, and transparency in documentation or data collection procedures. Simultaneously, COW is dedicated to making datasets freely available to the research community, releasing data promptly upon completion of data collection, assigning version numbers for datasets and replication tracking, providing appropriate dataset documentation, and updating, documenting, and distributing subsequent versions of datasets when appropriate; https://correlatesofwar.org/.

[21] https://www.researchgate.net/publication/234609611_The_Dag_Hammarskjold_Library_and_United_Nations_Documentation.

and Ideological Difference Matrix as dependent variables, the real-world multilevel social network model is calculated. Key parameters such as betweenness centrality, closeness centrality, correlation index, and cohesion index are processed using the software UCINET 6.0.

## 3 Results Analysis

### 3.1 Mechanisms of Lower-Level Contention and Core-Periphery Structure

#### 3.1.1 Hypotheses on the Mechanisms of Lower-Level Contention in the International Power Structure of South Asia

In the South Asia region, the disparity in national scale and power between the lower levels of the international power structure and other hierarchical levels is the fundamental cause of the dependency relationships of the lower levels on other hierarchical levels. It also serves as the primary driver for the emergence of collective action among the lower levels during resistance. When the power gap between lower-level states in the regional international power structure and states at other levels or among lower-level states is substantial, a spillover of power from stronger states to weaker states may occur. In practice, this could manifest as stronger states deploying peacekeeping personnel to weaker states or transferring/exporting weapons and equipment to them. When the power disparity between two actors within this social network model is minimal, the motivation to form tight alliances during contention is weaker, resulting in lower cohesion.

Another influencing factor on the mechanisms of lower-level contention in South Asia's international power structure is the geographical distance between actors. In this social network model, geographical distance between nodes may become a significant factor determining the direction and magnitude of power spillover during contention. Generally, within the same region, two countries with smaller geographical distances, particularly neighboring states, are more prone to geopolitical conflicts and territorial disputes. In contrast, countries with larger geographical distances are more likely to develop friendly and interdependent relationships based on mutual trust. On the other hand, at the political level, a critical condition for whether two countries can develop collective action is the alignment of their perspectives on international issues and the consistency of their international political ideologies. This indicator can be measured by the similarity of their voting records in the United Nations.

Regarding assumptions about the type of social network structure, the social network model of South Asia's international power structure is a complex multilevel model. India, Pakistan, Nepal, Bhutan, Sri Lanka, the Maldives, and Bangladesh are designated as n1, n2, n3, n4, n5, n6, and n7, respectively.

#### 3.1.2 Examination of the Core-Periphery Structure

In addition to the previously discussed parameters—degree centrality, betweenness centrality, closeness centrality, influence index, correlation index, and cohesion index—this section also requires the calculation of network density, network structural

entropy, and the examination of the core-periphery structure for the study of the actual social network model.

（1）Network Density

In a social network structure, the closeness of connections among nodes can be represented by network density. Network density is defined as the ratio of the actual number of relationships in the social network to the theoretically maximum possible number of relationships (see Equation 9). Where: Δ denotes network density; $g$ represents the total number of nodes in the social network; $L$ indicates the total number of relationships in the social network.

$$\Delta = \frac{2L}{g(g-1)} \tag{9}$$

（2）Network Structural Entropy

Network structural entropy can describe the degree of order within a social network (see Equations 10 and 11). If the relationships in a social network are random, and each actor contributes roughly equally to the network structure in terms of importance, the network can be considered disordered. If the relationships are non-random—meaning some actors have highly connected relationships with others, while some have low connectivity—the social network structure can be considered ordered. Where: $k_i$ represents the total number of edges connecting node $i$ to other nodes; $I_i$ denotes the importance of node $i$; $E$ represents the network structural entropy.

$$I = \frac{k_i}{\sum_{i=1}^{N} k_i} \tag{10}$$

$$E = \sum_{i=1}^{N} I_i \times \ln I_i \tag{11}$$

（3）Core-Periphery Structure Test

The core-periphery structure test enables the assessment of deviation between the ideal network structure and the actual network structure of a social network.[22] If the social network constructed in the study exhibits a core-periphery structure, it indicates that actors within the region demonstrate clustering tendencies—some nodes are closely interconnected, while others are marginalized. Marginalized actors exhibit fewer connections among themselves and rely on nodes at the center of clusters within the network structure.

[22] 刘军：《社会网络分析导论》，社会科学文献出版社，2004 年，第 266 页。

To determine whether the studied social network exhibits a core-periphery structure, it is first necessary to calculate the coreness product of each node in the actual social network. Using these results as independent nodes, an idealized model of the actual social network can be constructed. Within a pair of nodes: If both nodes have high coreness, the coreness product of the pair is also large, and the pair is classified into the group formed by core nodes; If one node has low coreness and the other has high coreness, the coreness product of the pair is moderate, and the pair is classified into the group formed by semi-peripheral nodes; If both nodes have low coreness, the coreness product of the pair is small, and the pair is classified into the group formed by peripheral nodes. The core-periphery structure of the actual social network is then tested by comparing the social network coefficients calculated based on the ideal network structure composed of these nodes with the correlation coefficients of the actual social network.

## 3.2 The Actual Social Network Model of the International Power Structure in South Asia

### 3.2.1 Overall Characteristics of the International Power Structure in South Asia

（1）Network Density Analysis

Between 2000 and 2019, economic ties among countries at the lower levels of the international power structure in South Asia remained consistently close. The network density of economic linkages consistently exceeded 0.98 and exhibited a gradual upward trend year by year, indicating a steady increase in economic and trade exchanges among countries in the region (see Figure 2). At the same time, military linkages among countries at the lower levels of the international power structure in South Asia were relatively limited. The low flow of arms trade resulted in a small network density within the social network structure, consistently remaining below 0.2.

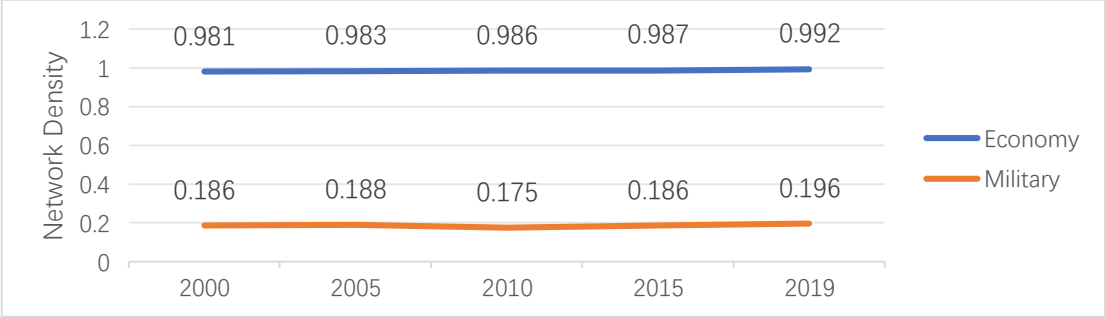



Figure 2 Analysis of Network Density in the Social Network of South Asia's International Power Structure

（2）Network Structural Entropy

Between 2000 and 2019, the network structural entropy of economic linkages among countries at the lower levels of South Asia's international power structure was relatively high, showing an initial increase followed by a decline and stabilization (see Figure 3). This indicates that prior to 2010, regional economic and trade activities exhibited greater disorder and a more pronounced trend toward decentralization. After 2010, the

disorder in regional economic and trade activities slightly decreased, and countries with relatively greater influence emerged within the structural network. Regarding military linkages in the region, the overall network structural entropy remained low and exhibited a declining trend. This suggests that the network structure consistently featured core countries with significant military influence, and the military power disparity between these core countries and others was substantial.

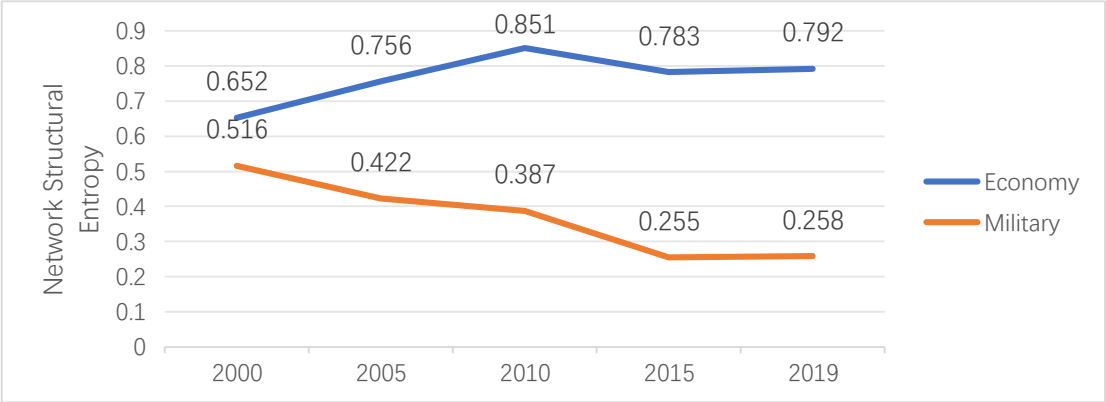



Figure 3 Analysis of Network Structural Entropy in the Social Network of South Asia's International Power Structure

### 3.2.2 Analysis of the Core-Periphery Structure in the Social Network of South Asia's International Power Structure

The fitting results of the core-periphery structure in the social network of South Asia's international power structure indicate that between 2000 and 2019, this value consistently remained above 0.92 and exhibited a year-on-year increasing trend (see Table 1). This suggests that economic and trade relationships within the social network of South Asia's international power structure have consistently exhibited a significant core-periphery structure. Actors in the region demonstrate clustering tendencies in economic and trade relations, with close economic ties among some nodes, while others remain marginalized. The underlying reason lies in the shared economic interests among countries in the region, as nodes within the network seek to maximize economic benefits through clustering to achieve mutual gains in trade. In contrast, the fitting correlation coefficient for the weapons trade network structure during the same period was relatively low, displaying volatility and instability. This indicates that, compared to economic and trade relations, actors in the region maintain a more distant and less interconnected relationship in military linkages. The primary reason for this is the predominantly unidirectional nature of weapons trade flows in the region, lacking tight mutual exchanges. As a result, a distinct core-periphery structure has not emerged in the military network.

Table 1 Fitting Results of the Core-Periphery Structure in the Social Network of South Asia's International Power Structure

| Year | 2000 | 2005 | 2010 | 2015 | 2019 |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| Economic Trade Network Structure Fitting Correlation Coefficient | 0.921 | 0.925 | 0.957 | 0.962 | 0.964 |
| Weapons Trade Network Structure Fitting Correlation Coefficient | 0.564 | 0.587 | 0.659 | 0.598 | 0.577 |

### 3.2.3 Parameter Characteristics of the Social Network in South Asia's International Power Structure

To measure the centrality of collective contention at the lower levels of South Asia's international power structure, the introduction of China's involvement in socio-economic development projects in South Asia enabled the construction of a real-world multilevel social network model of the region's international power structure. The corresponding parameter results are presented (see Table 2).

Table 2 Key Parameters of the Real-World Multilevel Social Network Model of South Asia's International Power Structure

| Parameter | | n1 | n2 | n3 | n4 | n5 | n6 | n7 |
|---|---|---|---|---|---|---|---|---|
| Degree Centrality | Initial Value | 4.84 | 3.22 | 1.36 | 1.20 | 1.87 | 0.90 | 1.95 |
| | Standardized Value | 0.81 | 0.54 | 0.23 | 0.20 | 0.31 | 0.15 | 0.33 |
| | Group Value | 4.71 | 4.71 | 4.71 | 4.71 | 4.71 | 4.71 | 4.71 |
| Betweenness Centrality | Initial Value | 1.67 | 1.33 | 0.50 | 0 | 0.33 | 0 | 0.33 |
| | Standardized Value | 0.11 | 0.09 | 0.08 | 0 | 0.02 | 0 | 0.02 |
| | Group Value | 0.019 | 0.019 | 0.019 | 0.019 | 0.019 | 0.019 | 0.019 |
| Closeness Centrality | Initial Value | 0.65 | 0.54 | 0.35 | 0.33 | 0.23 | 0.18 | 0.21 |
| | Standardized Value | 0.093 | 0.077 | 0.050 | 0.047 | 0.033 | 0.026 | 0.030 |
| | Group Value | 0.356 | 0.356 | 0.356 | 0.356 | 0.356 | 0.356 | 0.356 |
| Influence Index | | 5.68 | 4.47 | 1.92 | 1.18 | 1.86 | 2.01 | 1.33 |
| Correlation Index | | 20/21 | 20/21 | 20/21 | 20/21 | 20/21 | 20/21 | 20/21 |
| Cohesion Index | | 5 | 5 | 5 | 5 | 5 | 5 | 5 |

（1）Overall Power Characteristics

Whether measured by degree centrality, betweenness centrality, or closeness centrality, the initial values and standardized values of node n1 (representing India) consistently

rank first. This indicates that within the real-world multilevel network model incorporating China's participation in South Asia's socio-economic development, India occupies a dominant central position in the power structure. In other words, India plays a dominant role in the interactions of international affairs within the South Asia region. This conclusion is further corroborated by the results of the influence index, which similarly shows that India enjoys the highest prestige and comprehensive influence within the network. Therefore, measurements across all power indicators consistently demonstrate that India holds the most prominent position in the overall power structure of the South Asian regional social network.

（2）Centrality Analysis

From the perspective of initial degree centrality, node n1 (representing India) in the real-world multilevel model exhibits the highest value, indicating that the central node in this model possesses the greatest power and dominance, as well as the strongest control over other actors.[23] Node n2 (representing Pakistan) in the real-world multilevel model has the second-highest degree centrality, signifying that its power and dominance within the social network are second only to those of n1. The initial degree centrality values of nodes n1 and n2 are substantially higher than those of the other five nodes, further confirming that n1 and n2 hold the majority of power in the region. Regarding the group value of degree centrality, the value calculated for the real-world multilevel model is larger compared to the three ideal models constructed in the previous section. This suggests that after incorporating multidimensional relational data—such as real-world economic trade, arms flows, geographical distances, and ideological factors—more countries within the region are inclined to unite and participate in the process of lower-level contention.

From the perspective of initial betweenness centrality, nodes n1 and n2 in the real-world multilevel model also significantly surpass the other five nodes, with the initial betweenness centrality of n2 slightly lower than that of n1. This indicates that within this social network, n1 serves as the core node and the control center of the network, while n2 functions as the secondary core node, with its ability to control other actors being second only to that of n1. It is worth noting that the initial betweenness centrality values of node n4 (representing Bhutan) and node n6 (representing the Maldives) are zero, meaning that within this network model, these two actors occupy no brokerage positions in relational flows. Consequently, their structural access to information flows is comparatively limited, suggesting greater constraints on their capacity to leverage network position for strategic benefit—though this reflects structural positioning within the model and should not be taken as a direct measure of real-world political outcomes.

From the perspective of initial closeness centrality, nodes n1 and n2 in the real-world multilevel model exhibit higher values than the other five nodes, with the initial closeness centrality of n2 slightly lower than that of n1. This data indicates that within this social network, n1 and n2 not only possess significant control power over the

[23] Hafner-Burton E M, Montgomery A H. Globalization and the Social Power Politics of International Economic Networks[M]. Social Science Electronic Publishing.

network but are also less susceptible to influence from other actors. However, for the other five nodes, their distances to other nodes in the network are smaller,[24] making it easier for them to unite and take collective action. Additionally, these actors are more prone to forming external dependencies.

（3）Influence Index Analysis

From the perspective of the Influence Index, nodes n1 and n2 in the real-world multilevel model similarly far exceed the other five nodes, with the initial influence index of n2 slightly lower than that of n1. This reflects the disproportionate structural role of the power centers in the real-world multilevel model on the network structure. Both the core and secondary core nodes exhibit substantial volumes of both outward and inward flows relative to other nodes, indicating that they are the nodes engaging in relatively frequent interactions with others within the network structure.

（4）Correlation Index Analysis

Based on the comparative results of the Correlation Index, the value for the real-world multilevel model is higher than that of the simplified single-level and two-level models but slightly lower than that of the simplified seven-level model. This outcome corroborates the earlier analysis: in simplified models with absolute core nodes, interactions among other nodes are constrained. In the real-world multilevel model, despite the presence of two highly central nodes—India and Pakistan—communication among the remaining nodes remains more active compared to highly centralized simplified models. Therefore, the Correlation Index for the simplified single-level and two-level models is lower than that of the real-world multilevel model.[25] In contrast, while the Correlation Index of the real-world multilevel model is slightly lower than that of the simplified seven-level model (which lacks core nodes), the difference is marginal. Applying this result to the international power structure of South Asia reveals that the social network in this region is not strictly hierarchical. The overall structure is relatively flat, with fairly open channels for material and diplomatic linkages among countries, and the transmission efficiency of relational content is relatively high.

（5）Cohesion Index Analysis

Based on the measurement results of the Cohesion Index, the value for the real-world multilevel model is higher than that of the simplified single-level and two-level models but slightly lower than that of the simplified seven-level model. This indicates that, within this model, the degree of control exerted by the core and secondary core nodes in the real-world multilevel model over material and relational exchanges in the structural network is not yet excessive enough to substantially weaken the cohesion among the lower-tier states in the network structure. Furthermore, there is currently no significant risk of systemic collapse or disintegration of the relational structure.[26]

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[24] Gleditsch, Kristian S, Ward, etal. Measuring Space: A Minimum-Distance Database and Applications to International Studies[J]. Journal of Peace Research, 2001, 38 (6):739-758.

[25] 胡海波，王科，徐玲等：《基于复杂网络理论的在线社会网络分析》，载《复杂系统与复杂性科学》 2008 年第 5 期第 2 卷，第 1-14 页。

[26] Hafner B, Emilie M., Alexander H. Power positions: International organizations, social networks, and conflict[J].

Mapping this finding to the real-world context of South Asia, this result implies that despite the relatively central positions of India and Pakistan, the other five countries in the region maintain sufficiently robust direct or indirect connections among themselves. Such effective interactions and linkages among the lower-tier states form the foundation for maintaining the stability of the regional power structure, enabling the system to retain basic cohesion without disintegrating when confronted with internal contradictions.

## 4 Conclusions and Discussion

This study employs SNA to systematically examine the international power structure system of the South Asia region and its operational mechanisms, leading to several conclusions. First, economic linkages among countries in South Asia have consistently remained relatively strong, whereas the density of military interaction networks is comparatively low. Second, around 2010, the regional economic network structure exhibited a phased shift: prior to this period, trade networks displayed higher disorder and a pronounced trend toward decentralization; afterward, influenced by external factors, network orderliness increased. India has consistently remained a core state with prominent strength within military networks, maintaining a significant gap in military capabilities relative to other countries. Third, the economic relationship network exhibits a distinct core-periphery structure, with some nodes being closely connected while others tend toward marginalization. In contrast, the military network does not form a clear core-periphery structure, which stems from the unidirectional nature of weapons trade flows. Fourth, based on a comprehensive assessment of various centrality metrics, India consistently occupies the most central position within the regional power network, possessing a significant aggregate structural advantage. Fifth, after introducing China as an external factor and incorporating multidimensional real-world data, a comparison with the ideal model suggests that small states at the lower levels of the South Asian power structure show a greater structural tendency toward collective engagement and interdependence among themselves. It should be noted, however, that this observation reflects patterns within the constructed network model; causal interpretations regarding actual political behavior require further empirical validation. Sixth, analysis of the real-world multilevel model indicates that the hierarchical structure of the international power network in South Asia is not overly complex. India and Pakistan, serving as core and secondary-core nodes respectively, do not excessively undermine network cohesion among lower-tier states. The entire network demonstrates relatively high transmission efficiency in terms of both material and diplomatic linkages.

This study constructs a realistic model of the international power structure in South Asia through SNA. On one hand, the research establishes its analytical starting point based on the fundamental premise that power disparities lead to dependency and clustering. On the other hand, by incorporating the case of China's involvement in South Asian development, it builds a real-world multilevel network model. Utilizing

outcomes from core-periphery structure tests alongside parameters such as network density, network structural entropy, degree centrality, betweenness centrality, closeness centrality, influence index, correlation index, and cohesion index, the study systematically unveils the power dynamics and dependency relationships within the South Asian region.

This research still has certain limitations. It primarily focuses on the static structural characteristics among state actors, and its explanatory power regarding the dynamic evolution of power networks and causal mechanisms requires further depth. In terms of relational dimensions, it emphasizes traditional channels such as economics and military affairs, while integration of emerging modes of power flow—such as information, digital, and discursive channels—remains insufficient. Future research could introduce dynamic network analysis and process-tracing methods to further uncover the internal logic of power structure transformations. Simultaneously, expanding the collection and analysis of novel relational data—such as digital infrastructure, media networks, and transnational advocacy—would facilitate the construction of a South Asian regional power network model with greater contemporary explanatory power.

## Ethical Statement

This study did not involve human participants, animal subjects, or sensitive personal data. All data used are publicly available secondary sources. No ethical approval was required.

Data publicly available in a repository:

Primarily based on the SIPRI Yearbook on Armaments, Disarmament, and International Security published annually; https://www.sipri.org/yearbook/translations.

The GDP data for each actor are sourced from the economic and trade information provided annually by the World Bank; https://databank.worldbank.org/home.aspx.

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Using the voting records of countries in the United Nations General Assembly from the publicly available dataset of the Dag Hammarskjöld Library, ideological differences

between nodes in the constructed social network model are categorized; https://www.researchgate.net/publication/234609611_The_Dag_Hammarskjold_Library_and_United_Nations_Documentation.