Post-print of Global Shipping Strategic Node Identification

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Abstract

As dependence on ocean shipping for trade and strategic material transportation deepens, maritime shipping security has emerged as a strategic issue affecting national economic security. In this context, the development of shipping strategic pivots has become an important pathway for advancing the construction of the "21st Century Maritime Silk Road" and deepening global trade linkages. This article defines the scientific connotation of shipping strategic pivots, designs an identification methodology, and identifies such pivots on a global scale, aiming to provide a decision-making basis for the "Belt and Road" Initiative. The study reveals that shipping strategic pivots exhibit structural and spatial differentiation among strategic hubs, strategic corridors, and strategic maritime areas. Currently, there exist 44 strategic hubs globally, which respectively serve as control centers for regional shipping network organizations; there are 7 strategic corridors that cluster the world' s major shipping routes and cargo volumes and control the global transportation of strategic materials; and the three major shipping strategic maritime areas—the Caribbean Sea, Mediterranean Sea, and Southeast Asia-Pacific—have become indispensable transit points connecting important navigation zones and economic regions. These shipping strategic pivots exert significant influence on our country' s strategic material transportation and trade exchanges.

Full Text

Identification of Global Strategic Shipping Pivots

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Abstract

As global trade and strategic material transportation become increasingly dependent on ocean shipping, maritime shipping security has emerged as a strategic issue affecting national economic security. In this context, constructing strategic shipping pivots represents a crucial pathway for advancing the "21st Century Maritime Silk Road" initiative and deepening global trade linkages. This paper defines the scientific connotation of strategic shipping pivots, designs an identification methodology, and identifies such pivots globally to provide decision-making support for the Belt and Road Initiative. The findings reveal that strategic shipping pivots exhibit both structural and spatial differentiation across three categories: strategic hubs, strategic corridors, and strategic seas. Currently, 44 strategic hubs exist worldwide, serving as control centers for regional shipping network organization. Seven strategic corridors concentrate global shipping routes and cargo volumes while controlling the transportation of strategic materials worldwide. Three major strategic seas—the Caribbean, Mediterranean, and Southeast Asia-Pacific—have become essential passageways connecting important shipping regions and economic zones. These strategic shipping pivots exert significant influence on China's strategic material transportation and trade flows.

Keywords: strategic shipping pivot, strategic hub, strategic corridor, strategic sea, China, Belt and Road Initiative

With deepening economic globalization, trade linkages among countries worldwide have grown increasingly close. As the primary mode of international trade transportation, maritime shipping occupies an extremely important position in global cargo movement. Over 80% of China's foreign trade exports and more than 90% of strategic material imports such as petroleum and iron ore are transported by sea, making the security of China's overseas shipping a critical component of national security. This is also an important consideration in the Belt and Road Initiative construction.

Within complex shipping networks, certain locations become strategic pivots due to specific conditions, exercising control over global or regional shipping network organization and operations. Scholars have long analyzed the strategic significance of such pivots from various perspectives. Hub ports, as the "commanding heights" of shipping networks, have attracted considerable attention. An Xiaopeng and Han Zenglin et al. [1] analyzed the formation mechanisms and development patterns of international hub ports, Baird [2] examined the economies of scale in hub ports, while Song [3] analyzed competition among hub ports. The security of shipping corridors has become key to ensuring strategic material and international trade transportation safety for all nations. Li Bing [4] discussed the status and role of maritime strategic corridors, and Zhao Feng [5]

examined the characteristics, distribution, and significance of strategic straits. Managing shipping corridors has strategic implications for national security, with Wang Lirong [6] and Liang Jiarui [7] focusing on the strategic impacts of major shipping corridors on China, and Du Jie and Chou Hao [8] investigating interest relationships in shipping corridors. Some scholars have conducted multi-faceted analyses of specific hotspot seas, straits, and nodes. For instance, Shi Chunlin et al. [9] explored the impact of the Strait of Hormuz on oil transportation, while Cai Meijiang [10] and Li Zhen [11] examined the effects of the Panama Canal expansion on shipping markets. Shipping corridors concern national security and core interests, with Jia Dashan et al. [12] and Chen Jiayun [13] conducting safety assessments of maritime resource transportation and navigation environments. Few scholars have focused on identifying strategic shipping pivots, with only limited qualitative analyses available. Wang Chengjin [14] once used shipping company schedules to quantitatively identify hub ports.

Overall, existing research has addressed the distribution and strategic value of hub ports and shipping corridors but has not provided systematic analysis from the perspective of strategic shipping pivots. How to scientifically identify and construct strategic pivots remains a meaningful academic question. Therefore, this paper seeks to define the scientific connotation and identification methods of strategic shipping pivots, conduct quantitative identification at the global scale, reveal their spatial distribution patterns, and provide scientific evidence for smoothly advancing China' s Belt and Road Initiative.

1. Concepts and Methods

Strategic shipping pivot is a term that has gradually attracted scholarly attention since the Belt and Road Initiative was proposed. It specifically refers to locations in shipping networks that possess controlling or constraining effects on shipping organization and can effectively exert global or key supporting functions. The normal functioning of these pivots directly affects the smooth operation of shipping networks, making them essential passages for most shipping routes and convergence points for various interests, thus holding strategic value in both economic and security dimensions. As spatial scale changes, the scope encompassed by strategic shipping pivots also varies. From an economic geography perspective, we can examine the scientific connotation of strategic shipping pivots from three angles—point, line, and area—classifying them into strategic shipping hubs, strategic shipping corridors, and strategic shipping seas. Spatially, strategic hubs, corridors, and seas exhibit overlapping and intermingling distributions. Different types of strategic shipping pivots vary in scientific connotation, spatial form, and functional structure, requiring different identification and evaluation methods.

(1) Strategic Shipping Hub Identification involves screening hub ports with strategic significance from point-based ports. This paper employs a shipping network organization model and primacy connectivity to identify strategic hubs, using global shipping company schedules as data sources covering more

than 500 ports worldwide. Different levels or tiers of strategic hubs have varying control significance and functions in global shipping networks. This paper uses an indicator system to assess the hierarchy of each strategic hub, with evaluation indicators including port cargo throughput, shipping routes, sailing frequency, number of accessible ports, transport connection scale, and number of primary ports (Table 1).

(2) Strategic Shipping Corridor Identification involves screening strategically significant straits, canals, and narrow waterways globally. This paper primarily employs indicator evaluation methods. Aspects characterizing the strategic value of shipping corridors include shipping capacity, water depth, strategic materials, and location conditions. Specific indicators selected include cargo/ship traffic volume, channel depth, strategic material (including iron ore, petroleum, and coal) transport volume, and economic zone connectivity. The research sample comprises major world straits and canals, with basic parameter data obtained from online sources and cargo transportation and ship traffic data sourced from the U.S. Energy Information Administration, Lloyd' s Maritime Intelligence, and various canal authorities.

(3) Strategic Shipping Sea Identification involves discriminating navigation seas with strategic significance from global secondary shipping regions. This paper primarily employs indicator evaluation methods. Main characterization aspects of strategic seas include regime fragmentation, shipping corridor selectivity, and shipping base selectivity. Three specific indicators are selected: number of regimes, number of islands and straits, and number of hub ports. The weights of these indicators are calculated and set using the Analytic Hierarchy Process, and the weighted sum of each indicator yields the strategic value score for each location.

2. Identification and Spatial Patterns of Strategic Shipping Pivots

2.1 Strategic Shipping Hubs

Strategic shipping hubs are port nodes with dominant status and central functions, representing the "commanding heights" of shipping networks. As point-based strategic pivots, they are locations where numerous routes "converge and connect" and cargoes "consolidate and reorganize." Shipping hubs typically occupy important waterway junctions, serving as necessary passages for major world vessels, gathering numerous trunk and feeder routes, possessing high cargo throughput and accounting for significant proportions globally or regionally, controlling the spatial organization of shipping networks, and profoundly influencing shipping market operations. The study identifies 44 strategic shipping hubs worldwide, including Antwerp, Rotterdam, and Oslo in Northwest Europe; Valencia, Barcelona, Piraeus, Izmir, Ashdod, Istanbul, and Algeciras in the Mediterranean; Dubai, Jeddah, Colombo, and Delhi in the Middle East and South Asia; Singapore and Jakarta in Southeast Asia; Hong Kong, Shen-

zhen, Kaohsiung, Tokyo, Busan, Shanghai, Tianjin, and Qingdao in East Asia; Durban and Lourenco Marques on Africa' s east coast and Dakar and Lagos on Africa' s west coast; Melbourne, Sydney, and Lae in the Australia-New Zealand region; Chicago, New York, Charleston, Cortes, and Limon on North America' s east coast; and Vancouver, Oakland (U.S.), and Manzanillo on North America' s west coast; Cartagena, Santos, and Montevideo on South America' s east coast; and Callao and San Antonio on South America' s west coast. Within each shipping region, these strategic hubs hold leading and dominant positions and functions.

Spatially, these strategic hubs exhibit clear regionalization characteristics, with two or more hubs often forming in the same shipping region, particularly in East Asia and the Mediterranean. Influenced by land-sea distribution patterns, strategic hubs also show distinct north-south symmetrical layout features, prominently demonstrated on South America' s east coast. National political system constraints or interest subject differentiation also promote adjacent layouts of strategic hubs or create special phenomena of dual hubs in regional shipping organizations. Some shipping regions exhibit pluralistic patterns of strategic hubs, clearly manifested in the Mediterranean, East Asia, and Caribbean.

In terms of hierarchical structure, high-level strategic hubs constitute a minority, with the top three tiers accounting for only 18.6% of the total number of strategic hubs, while most hubs belong to the fourth and fifth tiers (Table 2). Among high-level hubs, East Asia forms an absolute advantage, while other shipping regions have relatively few. First and second-tier hubs are strategic hubs with global significance, while other tiers are primarily international or regional hubs. However, regardless of tier, all strategic hubs exercise central control functions over shipping organization in their respective regions. The port berths and associated logistics infrastructure of these strategic hubs often become focal points of attention and competition among terminal operators, shipping companies, and related investment groups. This makes focusing on point-based hubs, implementing concentrated efforts, and controlling commanding heights an important pathway for major shipping nations or port-shipping enterprises to enhance their global shipping resource allocation capabilities.

2.2 Strategic Shipping Corridors

Strategic shipping corridors refer to key shipping channels with constraining effects in shipping networks, typically narrow shipping waters such as strategic straits or canal passages. As linear strategic pivots, they are narrow waters where numerous international ocean shipping routes "converge and overlap" and cargo vessels "concentrate and pass through." Globally, there are thousands of straits and dozens of artificial canals with significant variations in length and water depth, among which approximately 50 are major or important straits and canals possessing different strategic significance (Figure 1 [Figure 1: see original paper]). The study reveals that globally important straits and canals include the Strait of Malacca, Strait of Gibraltar, English Channel-Dover Strait, Strait of

Hormuz, Strait of Mandeb, Florida Strait, Dardanelles Strait, Bosphorus Strait, Korea Strait, Mozambique Strait, and the Suez Canal, Panama Canal, and Kiel Canal.

These strategic corridors are all narrow navigable waters serving as maritime traffic corridors. Among them, the Strait of Malacca holds the highest shipping value with a score of 0.942, followed by the Suez Canal, Panama Canal, and Strait of Hormuz, all scoring above 0.83. Strategic corridors often represent the shortest navigation paths connecting two major shipping regions; for example, the Strait of Malacca connects East Asia with the Indian Ocean region, while the Panama Canal connects the Pacific and Atlantic Oceans. Water depth conditions give birth to the critical significance and strategic value of each corridor, thereby locking in navigation paths for different vessel sizes worldwide. For instance, the Panama and Suez Canals have depths of only 13 meters and 22.5 meters respectively, thus allowing maximum vessel drafts of 12 meters and 18.9 meters—Panamax and Suezmax vessels are designed as the largest ship types specifically for these two canals. Strategic corridors concentrate major global vessel traffic volumes and route organization, exercising obvious control over strategic material transportation. The Strait of Malacca handles 20-25% of world cargo traffic, the Strait of Hormuz transports 13.4 million barrels of crude oil daily, the Panama Canal passes 15,000 vessels annually, and the Suez Canal undertakes 70% of Middle East-to-Western Europe oil transportation. The Strait of Malacca controls China' s container and crude oil transportation, the Suez Canal, Strait of Gibraltar, and Panama Canal control China' s container transportation, and the Strait of Hormuz affects China' s oil transportation. Additionally, a few potential strategic corridors under consideration are also extremely important, including the Kra Isthmus Canal and Nicaragua Canal, which if successfully constructed would create alternatives to the Strait of Malacca and Panama Canal respectively.

Exerting influence and controlling navigation rights on strategic corridors has become an important strategy for world powers, leading some countries to construct shipping bases or even deploy military bases along these corridors. Consequently, strategic corridors have become focal points of global military and geopolitical struggles, with many nations waging wars lasting over a century for their control. For example, the United States controlled the Panama Canal for nearly 100 years and still provides military protection for it. From the 1880s to the 1950s, Britain maintained troops in the Suez Canal to control global shipping organization and strategic material transportation, ensuring its own interests while checking the power of other nations.

2.3 Strategic Shipping Seas

Strategic shipping seas refer to large maritime areas with multiple options, dense route distribution, and intensive vessel traffic in shipping organization. These are seas with numerous islands forming multiple straits or fragmented maritime spaces, typically regions with many political regimes and severe spatial fragmen-

tation. Their geographical locations are often special, either situated at global shipping chokepoints or at the intersection of multiple powers, where control by any single party can influence the overall situation. This paper evaluates major secondary seas globally and identifies three strategic shipping seas: the Mediterranean, Southeast Asia-Pacific, and Caribbean, with strategic values of 0.885, 0.754, and 0.735 respectively.

Strategic seas are mostly located at the intersection of important shipping regions or economic zones. The Mediterranean and Caribbean are situated at the intersections of Asia-Africa-Europe and North-South America respectively, while the Southeast Asia-Pacific region lies at the intersection of the North and South Pacific and between the Pacific and Indian Oceans. These seas connect to, neighbor, or cover many strategic corridors and hubs, forming numerous straits or navigation channels with large route selection options. The Caribbean has six straits and four hubs, with the Panama Canal as its gateway; the Mediterranean has nine straits and seven hubs, with the Suez Canal and Strait of Gibraltar as its gateways; the Southeast Asia-Pacific region has eleven straits and five hubs, with the Strait of Malacca as its gateway and Singapore Port as its core strategic hub.

Strategic seas contain numerous countries, islands, straits, and ports, but these countries are small with uneven development levels and complex regime intersections, resulting in severe national power dispersion and fragmentation. The Southeast Asia-Pacific region, Caribbean, and Mediterranean contain 11, 20, and 19 countries or regions respectively, promoting obvious adjacent competition in port construction and shipping organization. This leads to more complex relationships in shipping path selection, route organization, port construction, and shipping markets. The Mediterranean and Caribbean have important impacts on China' s container shipping, while the Southeast Asia-Pacific region has become a necessary sea area for China' s container, iron ore, and coal import transportation. In the Southeast Asia-Pacific region, the Sunda, Makassar, and Lombok Straits are particularly important, with the Sunda Strait serving as a strategic corridor between the Pacific and Indian Oceans, while the Lombok-Makassar Strait has become the main route for vessels over 200,000 tons between the Pacific and Indian Oceans and the primary channel for China' s iron ore and coal imports from Australia. Constructing port facilities and shipping bases on the important hub ports, waterways, and islands of strategic seas is particularly crucial for a nation' s shipping security.

3. Conclusions and Discussion

Strategic shipping pivots occupy important positions in global governance, political games, economic development, and military struggles, attracting high attention from all nations seeking to exert control or influence. The concept of strategic shipping pivots varies in connotation across spatial scales, divided into strategic shipping hubs, strategic corridors, and strategic seas. Strategic shipping hubs are point-based pivots with dominant status and central functions,

with 44 such hubs existing globally that control the spatial organization of global or regional shipping networks, exhibiting spatial distribution characteristics of regionalization, pluralism, adjacency, and symmetry. Their hierarchical structure shows clear differentiation, with few high-level hubs. Strategic shipping corridors are narrow shipping waters with constraining effects, mostly strategic straits and canals, with seven such corridors globally that concentrate major vessel traffic volumes and route organization, exercising control over strategic material transportation—particularly the Strait of Malacca and Suez Canal, which have the highest strategic significance and major impacts on China' s container and petroleum transportation. Strategic shipping seas include the Mediterranean, Caribbean, and Southeast Asia-Pacific, characterized by numerous countries, islands, and straits, high maritime spatial and regime fragmentation, and multiple options for shipping organization, especially the Southeast Asia-Pacific region which has important impacts on China' s strategic material transportation.

The shipping network is a global spatial network. Ensuring national shipping security and interests requires implementing a "going global" strategy, with high attention to investment, construction, and operation management of overseas strategic shipping pivots to build a global network of overseas shipping bases. China' s shipping strategy should evolve from emphasizing energy transportation security to safeguarding comprehensive maritime rights and interests. Especially with the deepening implementation of the Belt and Road Initiative, China' s focus should expand from resolving the "Malacca Dilemma" to multi-point and multi-line strategic planning. This study provides foundational data for China to accelerate the development of the "21st Century Maritime Silk Road Economic Belt," implement a deeper "going global" strategy, and establish strategic shipping pivots. China should aim to serve the global realization of national interests, using strategic shipping hubs, corridors, and seas as entry points to integrate various resources, construct a networked system of overseas shipping bases, enhance China' s dominance over global shipping resources, and ensure the smooth implementation of the Belt and Road Initiative.

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