

The Theoretical Logic and Pathways of Industrial Security Empowering High-Quality Development of the Marine Economy

Xinyi Gu*, Wangjing Zhao, Siqu Zhang

(Kewen College, Jiangsu Normal University Xuzhou 221132, China)

Abstract: As a pivotal “blue engine” sustaining national economic growth, the marine economy cannot operate securely without robust, system-wide safeguards derived from the domestic industrial base. Drawing on interdisciplinary insights from industrial security studies and marine economics, this paper unpacks the theoretical distinction between industrial security and the broader concept of industry security. It defines industrial security as a security form centred on manufacturing and underpinned by self-reliant, controllable foundational industrial capacities, before articulating what it means for such industrial security to empower marine economic development. Built upon a three-dimensional analytical framework covering foundational industrial capacity, industrial governance capacity and industrial innovation capacity, this paper identifies four interrelated transmission mechanisms: technology spillovers, industrial linkages, standard-oriented governance, and institutional transfer. Through these mechanisms, industrial security capacities diffuse into marine-related economic sectors. Targeted policy responses are proposed. This analysis suggests that industrial-security-driven empowerment of the marine economy constitutes a systematic strategic endeavour, one defined by capacity diffusion, institutional adaptation and systemic restructuring. The findings offer theoretical reference points for marine-economic security governance and ongoing efforts to build China into a maritime power.

Keywords: Industrial security; Marine economy; marine new quality productive forces

1 Introduction

Since the dawn of the 21st century, the ocean has evolved into a strategic arena for China’s pursuit of high-quality development, and its economic importance within the national economy has grown increasingly prominent. According to the 2025 China Marine Economy Statistical Bulletin published by the Ministry of Natural Resources, gross marine product reached RMB 11,018.0 billion in 2025, marking a year-on-year increase of 5.5 % and accounting for 7.9 % of national GDP. Value-added output from marine manufacturing alone hit RMB 3,523.3 billion, rising by 6.8 % —1.3 percentage points faster than overall marine-economic growth [1]. Impressive aggregate figures notwithstanding, overlapping risks cast a long shadow over future prospects. Escalating geopolitical frictions, resurgent trade unilateralism and more frequent extreme-weather events have combined to subject China’s marine economy to unprecedented external uncertainty and structural pressure. High-tech marine industries face compound threats: value-chain fragmentation and supply-chain disruptions have become tangible risks. Critical equipment and core processes remain import-dependent, while domestic supporting industries and indigenous supply capacity lag well behind practical demand, laying bare weaknesses in industrial resilience. Strengthening security safeguards for the marine economy is therefore far more than a peripheral policy concern; it bears directly on national economic security and the effectiveness of China’s maritime-power-building agenda. Industry security is widely recognised as one of the cornerstones of national economic security. Its intellectual origins stretch back to the classical economist Adam Smith, who advocated for the protection of domestic industries from the standpoint of national defence. Later thinkers including Alexander Hamilton and Friedrich List expanded these preliminary observations into coherent theoretical

DOI: 10.67762/z7ztkn98

Submission date: June 3, 2026

Corresponding author: Gu Xinyi

E-mail: 1772075114@qq.com

Fund Support: Jiangsu Provincial College Students Innovation and Entrepreneurship Training Program “Research on the Impact of Digital Inclusive Finance on the Green and High quality Development of China’s Marine Economy: A Case Study of 11 Provinces and Cities in Eastern China” (S202613988018).

frameworks [2]. As an economic form extending industrial activities into maritime space, the marine economy relies for its safe operation fundamentally on the overall security performance of the industrial system.

Yet existing scholarship has not adequately theorised how industrial security connects with marine-economic progress. Most industry-security research remains confined to land-based sectors such as manufacturing, agriculture and finance, with marine industries receiving comparatively scant scholarly attention. The stark mismatch between the high practical salience of marine industry security challenges and the slow pace of relevant academic research has created bottlenecks that hold back marine industrial upgrading. While a small body of work has begun constructing evaluation indicators and measuring marine-industry security performance, few studies systematically examine how industrial-security capacities actually spill over into marine domains. Three notable gaps persist within the existing literature. First, scholars have failed to develop cohesive theoretical frameworks that translate general industry-security theories into marine-industry contexts. Second, analyses of cross-domain capacity transmission mechanisms tend to be fragmented, lacking synthetic integration. Third, many published empowerment strategies read as disjointed policy inventories with thin theoretical grounding.

2 Conceptual Definition and Theoretical Foundations of Industrial Security Empowering High-Quality Development of the Marine Economy

2.1 Distinction of Industrial Security from the Broader Notion of Industry Security

To unpack what “industrial security empowers the marine economy” actually means, one cannot skip a critical preliminary task: sorting out how industrial security relates to the broader idea of industry security. These two terms are frequently conflated within Chinese-language policy and academic discourse, and such loose usage can muddle subsequent theoretical reasoning. Broadly defined, industry security refers to a condition where an industry retains room to survive and grow without facing existential hazards. This condition has two practical dimensions. One is survival-focused security, which guards against sudden industrial breakdown; the other is development-focused security, which supports ongoing industrial transformation and upgrading. Far from being a static benchmark, this concept shifts over time, shaped by constant tensions between domestic market dynamics and global economic pressures. A number of scholars have rightly pointed out that single-dimensional evaluations risk distorting real-world conditions. To draw a full picture of industry security, analysts ought to weigh internal weaknesses against outside hazards, self-defence capacities against long-run strategic positioning, and short-term operational outcomes against an industry’s ability to sustain itself into the future.

While industrial security shares conceptual ground with industry security, it carves out its own analytical territory. Industry security casts a wide net: it addresses security concerns across every sector of the national economy. Industrial security, however, narrows the industry security framework down to industrial domains specifically. Its analytical focus falls squarely on the functional security capacities of production systems built around manufacturing.

At the analytical level, industry security directs attention to intra-sector competition dynamics, market structures and policy environments. Industrial security emphasises the material-technological bedrock, indigenous supply capacity and systemic resilience of industrial systems. In practical terms, industry security centres on preserving overall security conditions for given industries; industrial security highlights the industrial system’s role as the economic underpinning, characterised by foundational support capacity, control over key links and continuous innovative potential.

With those conceptual distinctions established, we can now lay out our working definition of industrial security. For the purposes of this analysis, industrial security describes the overall capability of a production system anchored in manufacturing. When hit by outside shocks or troubled by internal vulnerabilities, such a system is able to operate independently, keep critical links from falling under foreign control, and preserve the basic integrity of its core operations. For one thing, it is distinct from workplace production safety, a concept centred on safeguarding staff and preventing on-site accidents. Nor should industrial security be confused with the far-reaching notion of industry security, which covers risk conditions across every economic sector. Most importantly, our definition highlights a role that frequently gets overlooked in existing discussions: the industrial system acts not merely as a source of technologies and physical hardware, but also as a central coordinating node that holds value-chain networks together.

2.2 Definition of Industrial Security Empowering High-Quality Development of the Marine Economy

Having clarified these conceptual boundaries, we move on to unpack what “industrial security empowerment of

the marine economy” actually entails. This paper therefore frames it not as some passive, automated outcome, but as an intentional, strategic undertaking. Capabilities built up within terrestrial industrial systems cannot simply flow into marine spheres of their own accord. Instead, these hard-won security strengths must go through deliberate reworking and context-specific adaptation. Only through multiple, distinct transmission channels can they effectively transfer and serve marine economic sectors. Such cross-domain diffusion delivers holistic improvements in security safeguards across core dimensions—equipment manufacturing, energy exploitation, industrial-supply-chain operation and sci-tech innovation—and consolidates solid security foundations for high-quality marine economic growth. Three core layers of meaning underpin this concept.

First, empowerment originates from composite security capacities embedded within industrial systems. These capacities are not isolated technical metrics but multi-factor complexes. They include foundational industrial capacity (hard resources such as materials, production hardware and processing techniques), industrial governance capacity (soft resources including technical standards, intellectual-property regimes and supply-chain governance), and industrial innovation capacity (dynamic strengths manifested in breakthrough technologies and exploration of emerging sectors). Mutually reinforcing, these three dimensions form an organic whole that underpins security-oriented empowerment for marine sectors. Existing scholarly work, which constructs marine high-tech industry security evaluation systems along the dimensions of developmental capacity, innovation capacity and governance capacity, lends further credibility to this three-part analytical structure [3].

Second, empowerment depends on deliberate systemic transmission and effective conversion of security capacities. Industrial security advantages do not translate automatically into marine economic security guarantees. Intentional mechanisms are required to realise cross-domain transfer and adaptive re-calibration when terrestrial-originated capacities move into marine settings. This process involves not only physical extension of material-technical capabilities but also logical expansion of institutional arrangements and governance experience. The crux lies in dismantling institutional barriers—embedded within technical standards, administrative models and regulatory regimes—that have long separated land-based and marine spheres.

Third, when we talk about empowerment, our end goal lies in lifting the overall security performance of the marine economy. It is important to draw a line here: this perspective moves past the common, narrow approach that merely patches up scattered weak points or fixes problems within one or two isolated marine sub-sectors. Such fragmented fixes might deliver short-term gains, yet they seldom address deeper systemic vulnerabilities. What we are after, rather, is progress at the system level. What does this system-wide improvement look like in practice? A robust marine economic system ought to hold steady when external shocks strike, bounce back quickly after disruptions take place, and keep pursuing structural shifts and performance gains even as external conditions keep shifting. This line of thinking overlaps substantially with established work on marine economic resilience, which describes how marine systems preserve, rebuild or rearrange their core functions and organisational structures under shock and uncertainty [4]. We can observe this broad-based progress through tangible real-world markers: more resilient marine industries, greater self-governance across critical industrial and supply-chain segments, and wider safety buffers that leave more room for marine economic activities to develop.

2.3 Core Characteristics of Industrial-Security-Driven Empowerment

In practical application, industrial security empowerment of the marine economy exhibits several distinctive attributes. In material terms, it rests squarely on foundational industrial capacities. Shipbuilding requires specialised steel grades; offshore engineering demands ultra-reliable components; offshore oil and gas extraction calls for drilling hardware built to withstand extreme operating conditions. The quality of the industrial base directly shapes material-technical conditions available for the marine economy to counter risks. Theoretically, the analytical framework draws upon industry security theory, enabling security assessments organised around developmental, innovative and governance related dimensions. Strategically, the whole process follows the logic of land sea coordination. Most existing industrial capacities are geographically rooted on land, while marine-economic growth unlocks new development spaces across coastal and offshore zones. Deep interconnection between the two spheres compels policymakers to discard siloed thinking that treats land and sea as disconnected domains [5]. Normatively, the entire empowerment endeavour serves to cultivate marine new quality productive forces—advanced productive forces brought about by revolutionary advances in marine resource utilisation, innovative factor allocation and deep going marine industrial transformation [6].

3 Transmission Mechanisms for Industrial Security Empowering High-Quality Development of the Marine Economy

Effective translation of industrial-security capacities into marine-economic outcomes presupposes unobstructed transmission channels and well-functioning conversion mechanisms. This study identifies four mutually complementary pathways: technology spillovers, industrial linkages, standard-oriented governance, and institutional transfer.

3.1 Technology Spillover Mechanism

Technology spillovers constitute the primary channel for diffusing industrial-security capacities into marine economic spheres. Over decades of development, industrial systems have amassed extensive know-how spanning materials science, manufacturing processes, automatic control and information technology, much of which proves highly transferable across sectoral boundaries. Once terrestrial-origin know-how finds practical application in building marine-grade equipment, developing ocean-based energy resources, and carrying out deep-sea survey work, marine industries stand to gain meaningful improvements to their technical foundations and baseline security conditions. It would be misleading, however, to assume these benefits materialise automatically. Technology spillovers are never guaranteed simply because advanced industrial techniques exist on land. Real-world outcomes depend on how well accumulated industrial technical know-how lines up with the capacity of marine-oriented enterprises to digest and repurpose outside expertise. Inside concentrated marine high-tech clusters, this knowledge transfer mostly happens through two practical channels: skilled employees moving between organisations, and joint research initiatives that pair academic institutions with industry players.

3.2 Industrial Linkage Mechanism

Industrial linkages deliver structural channels for security-capacity transmission. Forward and backward linkages intertwine industrial systems and marine economies. Industrial sectors supply marine producers with equipment, raw materials and intermediate components. In return, marine economic expansion generates fresh market demands and raises new technical challenges that feed back to terrestrial industries. Such two-way interdependence allows improvements in industrial security to propagate organically along value chains. Marine-equipment manufacturing operates within globally integrated production networks characterised by lengthy value chains. From raw-material provision, R&D and component production to final assembly, maritime services and post-project maintenance, every node remains deeply coupled to broader industrial systems. Transmission depth and efficiency correlate positively with the intensity of cross-sector industrial linkages.

3.3 Standard-Oriented Governance Mechanism

Standards represent vital normative carriers that institutionalise security practices. Technical specifications, safety codes, quality-management frameworks and testing protocols developed within terrestrial industries offer institutional templates that marine sectors may adopt or adapt. In essence, standard-oriented governance elevates proven industrial safety practices into formal normative requirements, and realises institutional migration of security capacities through cross-sector application. Three sequential stages underpin this mechanism. First, well-established industrial safety standards are adjusted to fit harsh marine environmental conditions. Second, mandatory or voluntary implementation embeds safety clauses into day-to-day marine production and operational routines. Third, feedback generated through real-world application triggers iterative updating of standards themselves. At present, there is an urgent need to reconcile terrestrial industrial standards with marine stressors such as high salt spray, persistent humidity and violent wave action, building a normative system that preserves strengths inherited from land-based practice while accommodating marine-specific constraints.

3.4 Institutional Transfer Mechanism

Institutional transfer acts as the deepest-seated safeguard for cross-domain diffusion of industrial-security capacities. Industrial systems have accumulated mature safety-management regimes, risk-prevention workflows, emergency-response protocols, and broader governance experience, all of which constitute transferable institutional resources for marine-security governance. Transfer cannot amount to crude copy-and-paste; instead, institutional arrangements must be adapted and locally reconstructed after acknowledging fundamental divergences between terrestrial and marine institutional contexts. Key operational steps include extending industrial work-safety accountability systems to offshore-engineering projects, adapting industrial supply-chain risk-assessment

methodologies for marine value chains, and refitting terrestrial emergency-management frameworks for remote offshore operations. The depth of institutional transfer determines whether empowerment remains confined to technical “hardware” support or advances into embedded governance-oriented “software”.

4 Practical Constraints

Industrial-security-driven marine empowerment is a systemic undertaking requiring multi-layered interactions between industrial and marine economic systems. China is still in the early stages of integrated development between these two spheres, and multiple practical constraints remain salient.

4.1 Insufficient Extension of Foundational Industrial Capacities toward Marine Applications

Foundational industrial capacities supply indispensable material-technical prerequisites for marine-economic empowerment. Nevertheless, China’s existing industrial base still fails to extend sufficiently to marine-specific demands. Furthermore, proven industrial safety-management practices and technical standards have not been systematically transferred to marine industries. Risk-assessment tools and hazard-identification protocols frequently lose validity when deployed offshore. This capability mismatch between terrestrial industrial supply and real-world marine needs significantly undermines on-the-ground empowerment outcomes.

4.2 Weak Autonomous Controllability within Critical Marine-Industry Nodes

The degree of autonomous control held by marine industries directly shapes overall marine economic security. Within ship-supporting industries, localisation rates for navigation-automation hardware stay comparatively low. Deep-sea exploration continues to be hampered by bottlenecks such as pressure-resistant power units. The structural paradox—oversupply of low-end products alongside shortages of high-end outputs—amplifies industry-security risks. These technological choke-points create fractures within empowerment transmission chains, making it difficult to consolidate bedrock security for the marine economy.

4.3 Underdeveloped Industrial-Safety Standard Regimes for Marine-Related Applications

Standards serve as key institutional conduits for security-capacity diffusion, yet China’s marine-relevant industrial-safety standard-setting lags behind practical needs. Existing standards-related obstacles fall into two distinct yet mutually reinforcing groups, neither of which should be overlooked when we examine how security capacities transfer toward marine sectors.

First, most widely-accepted industrial safety standards originated from on-land manufacturing scenarios. They were calibrated with factory-floor operating conditions in mind. When carried over directly to ocean-going settings, their technical indicators and assessment criteria struggle to cope with harsh marine realities: persistent salt spray, high ambient humidity, and continuous mechanical force exerted by ocean waves. Simple copy-paste adoption of terrestrial rules often yields misleading assessment results for marine-related facilities.

Second, marine-relevant safety norms suffer from institutional fragmentation. Different government bodies each issue their own sets of provisions, without a shared overarching coordinating framework. As a consequence, overlapping clauses and even conflicting requirements frequently crop up across separate regulatory texts. For firms trying to meet legal requirements and for regulators tasked with on-the-ground supervision, this creates very real practical headaches.

Taken together, these flaws in standard-building remove well-established institutional channels for spreading industrial-security practices. Governance work becomes less streamlined, while the overall transaction costs of marine safety oversight creep higher.

4.4 Incomplete Governance Mechanisms for Marine-Economic Security

Even with solid technical and standard-system foundations in place, industrial-security-led empowerment cannot deliver its full potential without properly aligned institutional governance. Governance mechanisms serve as the critical institutional backstop that turns theoretical capacity into real-world marine economic security outcomes. When we look at China’s existing institutional setup for marine economic security, however, several obvious shortcomings hold back effective implementation. Administrative responsibilities for marine-safety affairs are scattered across multiple agencies—covering marine affairs, industry, transport, and energy—without dedicated cross-departmental coordinating mechanisms. Risk-monitoring and early-warning architectures remain incomplete; information collection, analytical judgement, and warning dissemination have not formed closed-loop workflows. Legislative frameworks for marine-economic security contain evident gaps, especially in emerging domains such as deep-sea

mining, marine carbon sequestration, and subsea data centres. Multi-stakeholder collaborative mechanisms are not yet fully functional. Cooperation between governments, firms, research institutes, and social organisations remains loose, and market actors cannot fully exercise their agency within security governance. Consequently, the institutional synergies required for effective industrial-security empowerment have not yet materialised.

5 Optimisation Pathways for Industrial Security Empowering High-Quality Development of the Marine Economy

Against the array of constraints outlined above, targeted interventions must advance along four interlinked fronts: expanding foundational industrial capacities for marine applications, overcoming core technological bottlenecks within marine industries, refining marine-oriented industrial-safety standard systems, and improving marine economic security governance regimes.

5.1 Expanding Foundational Industrial Capacities toward Marine Applications

Foundational industrial capacities constitute the bedrock for industrial-security empowerment. Co-ordinated measures should unfold across supply-side, institutional, and infrastructural dimensions. On the supply side, marine-sector priority demands ought to be incorporated into national initiatives upgrading foundational industrial capacities. Increased R&D investment targeting marine-specific key materials and core components will strengthen indigenous industrial responsiveness to marine-industry requirements. Institutionally, proven industrial safety-management experience and technical standards should be channelled systematically toward marine sectors. Formalised, regular transmission mechanisms must be established to break down persistent land-sea institutional barriers. In infrastructural terms, investment should upgrade marine-relevant industrial infrastructure. Policymakers ought to support construction of intelligent-equipment R&D centres and industrial-internet platforms, extending digital-industrial infrastructure to marine industries and lifting the overall intelligence level of marine production hardware.

5.2 Breaking Core-Technology Bottlenecks within Marine Industries

Tackling technological choke-points represents the fundamental route for mitigating marine-industry vulnerabilities. Innovation chains deliver impetus for improving autonomous control over industrial chains, while value-chain governance provides essential institutional safeguards [7]. For indigenous research and development, authorities should concentrate resources on prominent weak links in marine high-tech sectors. Cross-administrative, cross-domain collaborative research projects should advance breakthroughs in deep-sea exploration, marine biomedicine, and seawater desalination. Leading marine enterprises should be encouraged to set up innovation consortia that drive synergistic progress across upstream and downstream value-chain participants. Regarding international engagement, policymakers should refine institutional environments for marine science and technology, fostering well-integrated university-industry-research ecosystems and smoothing pathways translating basic research into commercial deployment. Meanwhile, under the premise of safeguarding national security, China should actively participate in global marine-technology governance, leveraging open international exchanges to elevate indigenous innovation starting points.

5.3 Refining Marine-Relevant Industrial-Safety Standard Systems

Standard-setting forms core institutional infrastructure enabling industrial-security capacities to flow into marine economic spheres. Reform must address two core challenges: adaptive re-calibration and cross-agency harmonisation. In terms of adaptive transformation, the development of new industrial-safety standards tailored to marine operating conditions should be accelerated. Mature terrestrial practices need to be combined with marine-specific constraints including salt spray, humidity, and wave forces, generating normative systems that retain terrestrial merits while fitting marine realities. For cross-departmental harmonisation, administrative bodies should consolidate fragmented marine-relevant industrial-safety standards, resolve overlapping or conflicting clauses, and build logically ordered, hierarchically structured standard frameworks. In parallel, China should deepen engagement within international marine-safety standard-making processes to raise its normative voice, and implement dynamic revision mechanisms ensuring standards keep pace with technological evolution.

5.4 Refining Marine Economic Security Governance Mechanisms

Institutional arrangements furnish ultimate guarantees for industrial-security-driven empowerment. Reforms should advance along four mutually reinforcing dimensions. First, organisational coordination: build cross-departmental marine economic security coordination mechanisms with clearly defined central-local responsibilities, supported

by inter-ministerial joint-conference arrangements to deliver streamlined governance. Second, risk early-warning: deploy satellite remote-sensing and big-data analytics to build comprehensive monitoring networks. Closed-loop workflows covering risk assessment, warning dissemination, and emergency response should shift governance priorities from post-incident remediation toward pre-emptive risk prevention. Third, legal safeguards: fill legislative voids in emerging fields such as deep-sea mining and marine renewable energy, laying solid full-chain institutional foundations. Fourth, multi-stakeholder engagement: construct collaborative-governance ecosystems bringing together state agencies, enterprises, and research institutes, so as to mobilise combined institutional synergies for industrial-security-based marine empowerment.

6 Conclusion

Profound intrinsic connections and systematic transmission logic connect industrial security and the marine economy. Industrial-security-driven empowerment of the marine economy is far more than superficial technology transfer or mechanical replication of terrestrial experience. Instead, it represents a systematic strategic process encompassing capacity diffusion, institutional adaptation, and far-reaching systemic restructuring. By deploying an analytical framework of “conceptual definition–transmission mechanisms-practical constraints-optimisation pathways”, this paper systematically elaborates theoretical premises, internal logic, limiting factors, and remedial strategies for industrial-security empowerment, revealing underlying mechanisms through which the “industrial shield” protects the “blue engine”. Moving forward, within the strategic paradigm of land-sea coordination, China ought to promote efficient transmission and deep integration of industrial-security capacities into marine economic activities. Self-reliant, controllable industrial systems will consolidate security foundations for marine development; secure, resilient marine economies will, in turn, broaden strategic development space for the whole nation. Together, these developments will deliver robust security guarantees and sustained momentum supporting China’s maritime-power-building agenda.

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