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Inland Port Innovation and Firm Internationalization: A Hybrid SEM–fsQCA Analysis of Supply Chain Cognition and Institutional Dynamics

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Article

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Abstract

Against the backdrop of global logistics restructuring and the growing importance of inland trade corridors, inland ports are increasingly viewed as strategic platforms for supporting firm internationalization. This study integrates Transaction Cost Economics, Institutional Theory, and an internal–external dynamics perspective to develop a dual-path framework explaining how inland port innovation affects the internationalization outcomes of surrounding enterprises. Using survey data from 372 enterprise respondents located around selected inland port-related regions in Hebei and Henan Provinces, China, this study employs structural equation modeling and fuzzy-set qualitative comparative analysis. The SEM results show that infrastructure innovation significantly enhances supply chain resilience cognition, while operational model innovation strengthens logistics cost reduction cognition. Supply chain resilience cognition promotes external internationalization motivation, whereas logistics cost reduction cognition does not show a significant direct effect. Institutional innovation strengthens regulative and normative mechanisms, while normative and cognitive mechanisms enhance internal internationalization motivation. Both external and internal internationalization motivations are positively associated with internationalization outcomes, with internal motivation showing a stronger effect. The fsQCA results further reveal four equivalent pathways leading to high internationalization outcomes. Overall, this study uncovers the cognitive, institutional, and motivational mechanisms through which inland port innovation contributes to firm internationalization.

1. Introduction

Inland ports have become important components of regional logistics and international trade networks. Traditionally, they were viewed as inland extensions of seaports that connect hinterland regions with maritime transport, improve intermodal efficiency, and reduce seaport congestion [1]. However, recent studies describe inland ports more broadly as strategic regional platforms integrating logistics infrastructure [2, 3], technological capability, intermodal coordination, and regional development functions [4, 5]. Thus, inland ports may influence both cargo movement and surrounding firms' participation in international markets.

This broader role is particularly relevant to inland firms, whose internationalization depends not only on product competitiveness but also on logistics accessibility, supply chain reliability, customs procedures, coordination costs, institutional support, and international networks [6–8]. Distance from coastal ports often creates longer delivery times, higher logistics costs, greater uncertainty, and coordination difficulties [9, 10]. Inland port innovation may reduce these barriers through improved infrastructure, integrated logistics services, customs facilitation, and supportive institutional environments [8–10], thereby influencing firms' international market decisions.

Although previous studies have examined dry ports, hinterland connectivity, intermodal transport, technological efficiency, and logistics sustainability [3, 11–13], the effects of inland port innovation on firm-level internationalization remain underexplored. Existing research still concentrates largely on infrastructure planning, transport performance, and regional logistics systems [11, 12]. Moreover, inland ports do not automatically produce international expansion. Firms must perceive their innovations as reliable, cost-saving, institutionally supportive, and strategically useful, while possessing the motivation, managerial commitment, and organizational readiness needed to convert external opportunities into internationalization outcomes [14, 15].

To address this gap, this study develops an integrated framework explaining how inland port innovation affects the internationalization outcomes of surrounding enterprises [16–18]. Inland port innovation comprises infrastructure innovation, operational model innovation, and institutional innovation. Transaction Cost Economics explains how logistics uncertainty and coordination costs affect internationalization decisions [16]. Institutional Theory explains

how regulative, normative, and cognitive environments shape firm behavior [17, 18]. The internal–external dynamics perspective further suggests that external opportunities must be transformed into internal strategic motivation before generating internationalization outcomes [14, 19, 20].

Accordingly, this study examines how different forms of inland port innovation affect supply chain cognition and institutional mechanisms, how these factors shape external and internal internationalization motivation, and which combinations lead to high internationalization outcomes. Using survey data from 372 enterprise respondents, the study applies a hybrid SEM–fsQCA approach. SEM tests net effects and mediation mechanisms, while fsQCA identifies multiple configurations producing high internationalization outcomes [5, 21, 22]. This design captures both linear relationships and configurational complexity in firm internationalization [14, 20, 23].

This study makes several contributions. First, it extends inland port research from logistics infrastructure to firm-level internationalization [5, 20]. Second, it distinguishes supply chain resilience cognition from logistics cost reduction cognition and separately examines regulative, normative, and cognitive institutional mechanisms. Third, combining SEM and fsQCA provides a more comprehensive explanation of how inland port innovation affects internationalization through both linear relationships and configurational pathways [21–23]. Overall, the study conceptualizes inland ports as dynamic regional platforms supporting the internationalization of surrounding enterprises.

2. Literature Review

2.1 Inland Port Innovation and Regional Internationalization

Existing inland port studies have focused on hinterland connectivity, intermodal transport efficiency, logistics accessibility, and regional development [3, 5, 10, 11]. However, less attention has been paid to how inland port innovation influences firm internationalization. Inland port innovation comprises three dimensions: infrastructure innovation, operational model innovation, and institutional innovation [3, 7]. These represent improvements in logistics facilities and digital systems, integrated logistics services and one-stop customs clearance, and institutional support such as policy coordination, customs facilitation, and trade service mechanisms [8, 10]. Previous studies show that inland ports improve logistics accessibility, reduce transport costs, and strengthen regional logistics systems [5, 10, 11]. Building on this literature, this study argues that inland port innovation promotes firm internationalization through firm cognition, institutional mechanisms, and internationalization motivation.

2.2. Transaction Cost Economics: Logistics Cost and Supply Chain Resilience

Transaction Cost Economics explains how inland port innovation influences firms' internationalization decisions by reducing logistics uncertainty, coordination costs, and cross-border transaction costs [16, 24]. Improved infrastructure, logistics coordination, and customs facilitation reduce these barriers [2, 10].

This study captures this logic through logistics cost reduction cognition and supply chain resilience cognition. Logistics cost reduction cognition reflects firms’ perceptions that inland ports reduce transport, warehousing, customs, time, and coordination costs. Operational model innovation contributes through integrated services, digital platforms, and coordinated customs clearance, while logistics innovation improves coordination and responsiveness [10, 25]. Supply chain resilience cognition emphasizes logistics stability and the ability to withstand

disruptions [26, 27]. Infrastructure innovation, multimodal transport, digital tracking, and customs facilities enhance logistics reliability, while digital technologies improve visibility and resilience [27, 28]. Thus, inland port innovation supports internationalization by reducing costs and strengthening logistics stability.

These mechanisms differ conceptually. Cost reduction improves economic attractiveness, whereas resilience increases confidence under uncertainty. Accordingly, logistics cost reduction cognition and supply chain resilience cognition are treated as distinct mechanisms linking inland port innovation to external internationalization motivation.

2.3. Institutional Theory: Regulative, Normative, and Cognitive Mechanisms

Institutional Theory suggests that firms are influenced by both economic efficiency and institutional environments [29–31]. Inland port institutional innovation includes customs facilitation, bonded policies, government coordination, trade services, digital governance, and cross-border logistics policies that reduce uncertainty and improve business predictability. Institutional mechanisms consist of regulative, normative, and cognitive dimensions [29, 30]. Regulative mechanisms include policies, customs procedures, and administrative support. Normative mechanisms involve professional standards, service norms, and regional business practices. Cognitive mechanisms refer to shared understanding, knowledge diffusion, and firms' beliefs that internationalization is feasible and legitimate [30, 32].

These mechanisms may influence firms differently. Formal support can improve rapidly, whereas normative acceptance and cognitive understanding develop more gradually. Institution-based research likewise emphasizes that firms respond to both formal institutions and interpreted meanings [17, 31, 33]. Therefore, this study examines whether inland port institutional innovation strengthens these three institutional mechanisms and whether they promote internal internationalization motivation.

2.4. Internal and External Dynamics of Firm Internationalization

Firm internationalization depends on external conditions and internal strategic readiness [14, 20]. External conditions include logistics accessibility, institutional support, international networks, and trade infrastructure, whereas internal conditions involve managerial commitment, organizational capability, resource allocation, and willingness to enter foreign markets [14, 15]. Firms internationalize only when external opportunities are translated into internal motivation [20].

External internationalization motivation reflects firms' perceptions that inland ports improve logistics access, institutional support, and international opportunities. Internal internationalization motivation reflects firms' willingness and commitment to invest in foreign market development [15, 20]. Distinguishing these motivations clarifies how external opportunities become strategic actions.

Internationalization outcomes include international network expansion, internationalization speed, import–export growth, and broader business performance [34, 35]. Prior research highlights the importance of international networks [34, 36] and broader performance indicators beyond export growth [35, 37]. Accordingly, this study measures outcomes using international network expansion, internationalization speed, and import–export growth.

Previous research also suggests that internationalization can result from multiple pathways rather than a single universal process [21, 22]. This supports combining SEM and fsQCA to capture both net effects and configurational pathways leading to internationalization outcomes.

3. Model Development and Hypotheses

3.1 Model Development

As illustrated in Fig. 1, this study explains how infrastructure, operational model, and institutional innovation influence the internationalization outcomes of firms surrounding inland ports. These innovations jointly reshape logistics conditions, institutional environments, and internationalization motivation. Inland ports are therefore viewed as regional platforms supporting supply chain security, logistics efficiency, policy access, and international market participation [5, 13, 38–40]. The model integrates Transaction Cost Economics, Institutional Theory, and the internal–external dynamics perspective. These theories explain how inland port innovation reduces uncertainty and coordination costs [41], shapes firms through rules, norms, and shared cognition [30, 42, 43], and converts external opportunities into internal motivation and organizational readiness.

The first route is the supply chain cognition pathway. Infrastructure innovation strengthens supply chain resilience cognition, while operational model innovation enhances logistics cost reduction cognition through integrated services, digital platforms, customs facilitation, and multimodal coordination [44, 45]. These perceptions promote external internationalization motivation, although resilience may directly strengthen confidence, whereas cost reduction may serve mainly as a supporting condition [27, 46].

The second route is the institutional pathway. Institutional innovation operates through regulative, normative, and cognitive mechanisms, including policy support, professional standards, knowledge diffusion, and perceived legitimacy. These mechanisms strengthen internal internationalization motivation, while external motivation further reinforces internal motivation. Internationalization outcomes are measured through network expansion, internationalization speed, and import–export growth. Overall, the model combines supply chain and institutional pathways to explain firm internationalization.

Note

IPI = Inland Port Infrastructure Innovation; OMI = Inland Port Operational Model Innovation; INI = Inland Port Institutional Innovation; SCRC = Supply Chain Resilience Cognition; LCRC = Logistics Cost Reduction Cognition; RIM = Regulative Institutional Mechanism; NIM = Normative Institutional Mechanism; CIM = Cognitive Institutional Mechanism; EIM = External Internationalization Motivation; IIM = Internal Internationalization Motivation; IO = Internationalization Outcomes.

3.2 Supply Chain Cognition Pathway

Inland port infrastructure innovation refers to improvements in physical and digital infrastructure that support international logistics and trade activities. These improvements may include multimodal transport facilities, railway–road connections, bonded warehouses, customs inspection facilities, digital logistics systems, and international cargo-handling capacity. Dry port research suggests that inland ports can improve hinterland connectivity and provide more efficient logistics solutions for firms located away from seaports [2, 38]. Recent studies further show that inland ports with stronger spatial value, technological capability, and intermodal integration can contribute to regional logistics efficiency and hinterland development [3, 5]. From a supply chain perspective, better infrastructure can reduce uncertainty and strengthen the stability of logistics operations. When firms perceive that inland port infrastructure improves transport continuity, delivery reliability, and emergency response capacity, they are more likely to develop stronger supply chain resilience cognition.

Supply chain resilience has been widely understood as the ability of a supply chain to prepare for, respond to, and recover from disruptions while maintaining operational continuity [47, 48]. Recent studies have extended this view by emphasizing the role of digitalization, supply chain memory, and information-processing capability in strengthening resilience and robustness [27, 28]. This is particularly relevant to inland ports because modern inland port systems increasingly rely on digital platforms, customs information systems, logistics tracking, and multimodal coordination. Therefore, infrastructure innovation is expected to strengthen firms' perception that their international supply chains are more reliable, secure, and responsive.

H1

Inland port infrastructure innovation has a positive effect on supply chain resilience cognition.

Inland port operational model innovation refers to the development of new logistics service models and operational arrangements. These may include one-stop customs clearance, integrated logistics services, digital freight platforms, multimodal transport coordination, and supply chain service integration. Compared with infrastructure innovation, operational model innovation focuses more directly on service processes, coordination efficiency, and cost reduction. Logistics innovation research shows that new logistics processes and value-oriented service models can improve responsiveness and reduce inefficiencies in logistics systems [44, 45]. From the perspective of Transaction Cost Economics, smoother logistics coordination and clearer operational procedures can reduce transaction costs related to information search, negotiation, monitoring, waiting time, and cross-border coordination [16].

Recent research on dry ports, intermodal transport, and synchromodal freight systems also supports the idea that operational coordination can reduce inland freight transport costs and time [2, 9, 10, 49, 50]. In the inland port context, firms may perceive operational model innovation as useful when it simplifies customs clearance, reduces repeated coordination, and improves the predictability of international logistics services. Therefore, when firms perceive that inland port operational innovation makes international logistics less costly and easier to manage, they are more likely to develop stronger logistics cost reduction cognition.

H2

Inland port operational model innovation has a positive effect on logistics cost reduction cognition.

Supply chain resilience cognition reflects firms' perception that inland port services improve the stability, reliability, and recoverability of their supply chain operations [47, 48]. For firms considering internationalization, supply chain reliability is not only an operational concern but also a strategic condition. When firms believe that inland ports can reduce logistics disruption, improve delivery reliability, and enhance supply chain security, they may perceive international market participation as more feasible [27, 28]. This perception can strengthen external internationalization motivation because firms become more confident in responding to cross-border market opportunities [20, 51]. In this way, supply chain resilience cognition reduces perceived uncertainty and helps firms view internationalization as a more manageable strategic option.

H3a

Supply chain resilience cognition has a positive effect on external internationalization motivation.

Logistics cost reduction cognition refers to firms' perception that inland port services reduce transport costs, warehousing costs, customs clearance costs, time costs, and coordination costs. Lower perceived logistics costs

can make international market participation more attractive because firms may expect cross-border trade to become less expensive and less complicated [7, 8]. Transaction cost logic suggests that firms are more likely to engage in external market activities when coordination and exchange costs are reduced [16]. In the inland port context, operational innovations that reduce logistics costs may therefore strengthen firms' external internationalization motivation by improving the perceived economic feasibility of international business. However, cost reduction is treated here as a motivational antecedent rather than a sufficient condition by itself, because internationalization also depends on market opportunities, firm resources, and strategic readiness.

H3b

Logistics cost reduction cognition has a positive effect on external internationalization motivation.

3.3. Institutional Dynamics Pathway

Inland port institutional innovation refers to policy, regulatory, administrative, and governance innovations that facilitate international trade and logistics activities. It includes customs facilitation, bonded policies, trade service support, government coordination, digital governance platforms, and cross-border logistics policy innovation [3, 8]. Institutional Theory suggests that firms' strategic behavior is shaped by regulative, normative, and cognitive institutional environments [29, 30, 52]. In inland port regions, institutional innovation may reduce policy uncertainty, simplify administrative procedures, improve regulatory efficiency, and provide formal support for firms' internationalization. When firms perceive that the inland port provides clearer rules and stronger administrative support, the regulative environment for international business becomes more favorable.

H4a

Inland port institutional innovation has a positive effect on regulative institutional mechanisms.

Institutional innovation may also shape the normative environment surrounding enterprises. When inland ports promote standardized customs services, professional logistics practices, international trade service norms, and regional cooperation standards, firms may perceive internationalization as a more accepted and encouraged business practice. Normative mechanisms matter because firms do not make strategic decisions only in response to formal rules. They also respond to expectations, standards, and the behavior of peer firms in the same region or industry [31, 52]. Therefore, inland port institutional innovation is expected to strengthen normative institutional mechanisms by making international trade more visible, accepted, and professionally supported.

H4b

Inland port institutional innovation has a positive effect on normative institutional mechanisms.

Inland port institutional innovation can also influence cognitive institutional mechanisms by improving firms' understanding of international trade procedures, cross-border logistics operations, customs rules, and foreign market opportunities. Through policy communication, service platforms, training programs, and knowledge diffusion, firms may develop a stronger perception that internationalization is feasible, legitimate, and strategically valuable [30, 32]. However, cognitive change is often slower than changes in formal rules or service norms, because it depends on learning, accumulated experience, and shared understanding. Even so, institutional innovation is expected to provide the basis for stronger cognitive institutional mechanisms [33].

H4c

Inland port institutional innovation has a positive effect on cognitive institutional mechanisms.

Regulative institutional mechanisms provide formal rules, policy incentives, and administrative support for firms' internationalization [17, 29, 30]. When firms receive clearer policy signals, customs facilitation, and government support, the uncertainty and institutional barriers associated with internationalization may be reduced. This can encourage firms to view internationalization as a more legitimate and supported strategic choice [17, 31]. At the same time, regulative support may not automatically become internal motivation unless firms also perceive clear business value and organizational feasibility. Therefore, this study proposes a positive relationship while recognizing that the effect of formal regulation may depend on how firms interpret and use institutional support [20].

H5a

Regulative institutional mechanisms have a positive effect on internal internationalization motivation.

Normative institutional mechanisms reflect industry expectations, professional standards, and regional business norms. When international trade becomes a widely accepted and encouraged practice in inland port regions, firms may feel stronger normative encouragement to align with regional internationalization trends. This does not necessarily mean coercive pressure. More often, it means that internationalization becomes a normal and desirable development direction. Firms may therefore become more internally motivated to participate in international markets when the surrounding institutional environment encourages and legitimizes international business behavior [29, 33, 52].

H5b

Normative institutional mechanisms have a positive effect on internal internationalization motivation.

Cognitive institutional mechanisms refer to shared beliefs, knowledge structures, and collective understandings that make internationalization appear legitimate and achievable [29, 30]. When firms better understand international market rules, logistics procedures, customs processes, and trade opportunities, they may develop stronger strategic confidence and readiness for internationalization. Compared with regulative support, cognitive mechanisms are closer to the internal decision-making process because they shape how managers understand opportunities and evaluate feasibility [32]. Therefore, cognitive institutional mechanisms are expected to strengthen internal internationalization motivation.

H5c

Cognitive institutional mechanisms have a positive effect on internal internationalization motivation.

3.4. Internationalization Motivation and Outcomes

External internationalization motivation reflects firms' perception that the external environment provides favorable conditions for international expansion. These conditions may include improved logistics access, lower perceived transaction costs, clearer trade procedures, stronger policy support, and more visible international market opportunities. However, external opportunities alone may not directly lead to internationalization unless firms translate them into internal strategic willingness and organizational readiness [14, 20]. Internationalization research has shown that firms' foreign market development depends not only on external opportunities but also on internal capabilities, managerial orientation, networks, and resource commitment [34, 36, 51]. Therefore, when firms

perceive that the inland port environment reduces external barriers and creates international opportunities, they are more likely to develop internal motivation to allocate resources and engage in international business.

H6

External internationalization motivation has a positive effect on internal internationalization motivation.

External internationalization motivation may also directly influence internationalization outcomes. When firms perceive that the external environment created by inland port innovation provides better logistics access, lower costs, and stronger market opportunities, they may be more likely to expand international networks, enter foreign markets faster, and increase import–export activities. Network-based internationalization research suggests that access to external relationships and market connections can support international expansion and performance [34, 37]. In the inland port context, external motivation may therefore help firms take advantage of logistics and market opportunities created by regional platform development.

H7

External internationalization motivation has a positive effect on internationalization outcomes.

Internal internationalization motivation represents firms' strategic willingness, managerial commitment, and organizational readiness to pursue international expansion. Firms with stronger internal motivation are more likely to allocate resources to cross-border trade, develop international partnerships, respond to foreign market opportunities, and sustain international business activities. Studies on born-global firms, internationalization speed, and export performance suggest that organizational capabilities, strategic commitment, and international market orientation are important for internationalization outcomes [35, 53, 54]. Therefore, internal motivation is expected to play a direct role in improving firms' internationalization outcomes, including network expansion, internationalization speed, and import–export growth.

H8

Internal internationalization motivation has a positive effect on internationalization outcomes.

4. Research Methodology

4.1. Research Model

Based on the theoretical model developed in Section 3, this study operationalized the research framework using 11 first-order latent constructs: inland port infrastructure innovation, inland port operational model innovation, inland port institutional innovation, supply chain resilience cognition, logistics cost reduction cognition, regulative institutional mechanism, normative institutional mechanism, cognitive institutional mechanism, external internationalization motivation, internal internationalization motivation, and internationalization outcomes [3, 5, 16, 20, 30, 34, 37, 47, 48]. The SEM analysis was used to test the hypothesized net effects and mediation mechanisms among these constructs, while fsQCA was used to identify alternative configurations leading to high internationalization outcomes [21, 55]. This design allows the study to examine both linear causal relationships and configurational complexity.

4.2. Measurement Items

All constructs were measured using multi-item scales adapted from established studies to the context of inland port innovation and firm internationalization [3, 5, 16, 20, 30, 34, 37, 47, 48, 56]. Items were designed for managers and senior employees familiar with logistics, international trade, supply chains, or strategic decision-making. All items used a five-point Likert scale ranging from 1 = strongly disagree to 5 = strongly agree. The questionnaire was reviewed by relevant researchers and pilot-tested with enterprise respondents to ensure clarity and contextual suitability [56–59].

Inland port innovation comprised infrastructure, operational model, and institutional innovation [3, 5]. The model also measured supply chain resilience cognition, logistics cost reduction cognition [16, 47, 48], regulative, normative, and cognitive institutional mechanisms [29, 30], external and internal internationalization motivation [20], and internationalization outcomes through network expansion, internationalization speed, and import–export growth [34, 37]. The full measurement items and sources are presented in Table 1.

Table 1
Measurement items and sources.

Construct	Code	Adapted Measurement Item	Source
Inland Port Infrastructure Innovation	IPI1	The inland port in our region has improved transport infrastructure for international logistics.	Adapted from Roso et al. (2009)[38]; Ng and Gujar (2009) [60]; Mentzer et al. (2001)[61]
	IPI2	The inland port provides better multimodal transport connections, such as railway–road or sea–rail links.	
	IPI3	The inland port has improved customs inspection, warehousing, and logistics facilities.	
Inland Port Operational Model Innovation	OMI1	The inland port provides more integrated logistics services than before.	Adapted from Grawe (2009) [44]; Mentzer et al. (2001)[61]; Flint et al. (2005)[45]
	OMI2	The inland port has improved one-stop or coordinated service models for customs clearance and logistics.	
	OMI3	The inland port uses digital platforms to improve logistics coordination and service efficiency.	
Inland Port Institutional Innovation	INI1	The inland port has introduced policies or service mechanisms that support firms' international trade.	Adapted from Kostova and Roth (2002)[30]; Xu and Shenkar (2002)[42]; Palthe (2014) [43]
	INI2	The inland port has improved coordination among customs, logistics providers, government departments, and enterprises.	
	INI3	The inland port has created a more convenient institutional environment for import and export activities.	
Supply Chain Resilience Cognition	SCRC1	The inland port improves the stability of our firm's supply chain operations.	Adapted from Ponomarov and Holcomb (2009)[47]; Ambulkar et al. (2015)[62]; Chowdhury and Quaddus (2017)[63]
	SCRC2	The inland port reduces the risk of logistics disruption in our international business.	
	SCRC3	The inland port helps our firm respond more effectively to unexpected changes in logistics or delivery.	
Logistics Cost Reduction Cognition	LCRC1	The inland port helps reduce our firm's logistics costs.	Adapted from Rindfleisch and Heide (1997)[41]; Mentzer et al. (2001)[61]; Flint et al. (2005) [45]
	LCRC2	The inland port reduces the time cost of customs clearance and cargo transportation.	
	LCRC3	The inland port reduces coordination costs between our firm and logistics service providers.	

Construct	Code	Adapted Measurement Item	Source
Regulative Institutional Mechanism	RIM1	The inland port provides clear policies and rules that support firm internationalization.	Adapted from Kostova and Roth (2002)[30]; Xu and Shenkar (2002)[42]; Palthe (2014)[43]
	RIM2	Government departments provide effective administrative support through the inland port.	
	RIM3	Customs and regulatory procedures at the inland port are becoming more convenient for enterprises.	
Normative Institutional Mechanism	NIM1	The inland port promotes standardized logistics and trade service practices.	Adapted from Kostova and Roth (2002)[30]; Xu and Shenkar (2002)[42]; Palthe (2014)[43]
	NIM2	Firms around the inland port are increasingly encouraged to participate in international business.	
	NIM3	International trade has become a more accepted business practice in the inland port region.	
Cognitive Institutional Mechanism	CIM1	The inland port helps firms better understand international trade procedures.	Adapted from Kostova and Roth (2002)[30]; Xu and Shenkar (2002)[42]; Palthe (2014)[43]
	CIM2	The inland port improves firms' knowledge of international logistics and customs processes.	
	CIM3	The inland port makes internationalization seem more feasible for surrounding enterprises.	
External Internationalization Motivation	EIM1	The inland port creates favorable external conditions for our firm to enter international markets.	Adapted from Yiu et al. (2007) [64]; Kiss et al. (2012)[65]; Leonidou et al. (2002)[66]
	EIM2	The logistics advantages provided by the inland port increase our firm's willingness to expand internationally.	
	EIM3	The inland port makes international market opportunities more accessible to our firm.	
Internal Internationalization Motivation	IIM1	Our firm has a strong internal willingness to expand international business.	Adapted from Knight and Cavusgil (2004)[53]; Yiu et al. (2007) [64]; Kiss et al. (2012) [65]
	IIM2	Our management team is committed to promoting internationalization.	
	IIM3	Our firm is willing to allocate resources to develop international markets.	
Internationalization Outcomes	IO1	Our firm has expanded its international business network, including overseas customers, suppliers, or logistics partners.	Adapted from Zhou et al. (2007)[67]; Casillas and Acedo (2013)[68]; Zou et al. (1998) [69]; Cavusgil and Zou (1994) [70]

Construct	Code	Adapted Measurement Item	Source
	IO2	Our firm has accelerated its entry into or expansion within international markets.	
	IO3	Our firm's import–export volume, sales, or overall international business scale has increased.	

For data analysis, the reliability and validity of the measurement model were assessed before testing the structural model. Cronbach's alpha and composite reliability were used to evaluate internal consistency, while standardized factor loadings and average variance extracted were used to assess convergent validity. Discriminant validity was examined using the Fornell–Larcker criterion [71].

4.3. Survey Design and Data Collection

This study used a structured online questionnaire to collect firm-level data from enterprises located around inland port-related regions in China [56]. Fieldwork was conducted mainly in Hebei and Henan Provinces between January and June 2025. The sample included manufacturing, logistics, trading, supply chain, and import–export firms located near logistics hubs, bonded zones, multimodal transport areas, and related industrial clusters.

Data were collected through a fully online, non-face-to-face survey distributed electronically through relevant online communication channels. Participation was voluntary, and no directly identifiable or sensitive personal information was collected. Under Article 32 of China's Measures for Ethical Review of Life Science and Medical Research Involving Humans, research using anonymized information data that causes no harm and involves neither sensitive personal information nor commercial interests may be exempt from ethical review. Therefore, no additional local ethical review was required for the survey conducted in China. The full regulation, including the applicable exemption provision, is publicly available on the official website of the National Health Commission of the People's Republic of China (https://www.nhc.gov.cn/wjw/c100375/202302/902b4a1dc3af4aba862a6387e6e376dc.shtml). Before data collection, the research protocol and survey procedures were reviewed and approved by the Department of Global Convergence at Kangwon National University as part of its internal academic and administrative oversight at 2 January 2025 [reference number: 20250201]. All procedures were conducted in accordance with the Declaration of Helsinki and relevant ethical guidelines and regulations.

Respondents were informed of the study purpose, voluntary participation, anonymity, and the exclusive academic use of their responses, and electronic informed consent was obtained before participation. The survey targeted managers, senior employees, and staff familiar with their firms' logistics, supply chain, import–export, or international business activities. Duplicate responses from the same enterprise were screened, and only the most complete response was retained.

The questionnaire collected respondent and firm characteristics, perceptions of inland port innovation, supply chain cognition, institutional mechanisms, internationalization motivation, and internationalization outcomes. A convenience sampling approach was adopted because respondents required relevant knowledge of inland port logistics and international business activities [72]. After invalid and incomplete responses were removed, 372 valid questionnaires remained. This sample was suitable for SEM and fsQCA analyses [73, 74]. Common method bias was also assessed before the measurement and structural model analyses [75].

4.4. Data Analysis Method

The data analysis combined structural equation modeling (SEM) and fuzzy-set qualitative comparative analysis (fsQCA). SEM examined the measurement model, structural relationships, and mediation effects, while fsQCA identified sufficient configurations leading to high internationalization outcomes [21, 55]. This design captured both linear net effects and configurational complexity, recognizing that multiple combinations of conditions may produce the same outcome [21, 76].

SEM followed the recommended two-step approach [55]. Confirmatory factor analysis first assessed whether the observed items adequately represented their latent constructs. Model fit was evaluated using χ^2/df, NFI, IFI, TLI, CFI, RMSEA, and PCLOSE [77]. Reliability and validity were examined through Cronbach's alpha, composite reliability, standardized factor loadings, average variance extracted, and the Fornell–Larcker criterion [77, 78]. The structural model was then tested, and mediation effects were assessed using bias-corrected bootstrap confidence intervals [79]. An indirect effect was significant when the interval excluded zero and the bootstrap p-value was below 0.05. Construct-level variance inflation factors were also examined for multicollinearity.

fsQCA complemented the SEM analysis. The outcome was high internationalization outcomes, and the conditions included infrastructure innovation, operational model innovation, institutional innovation, supply chain resilience cognition, logistics cost reduction cognition, and external and internal internationalization motivation. Regulative, normative, and cognitive institutional mechanisms were excluded because they were treated as intermediate mechanisms in SEM. Including them together with institutional innovation would have increased limited diversity in the truth table. All variables were calibrated using the direct method [21, 74]. Necessity analysis used a consistency threshold of 0.90, while sufficiency analysis applied a frequency threshold of 3 and a consistency threshold of 0.80. The intermediate solution was reported, and robustness was checked by raising the consistency threshold to 0.85 [76]. This approach identified both average net effects and alternative configurations leading to high internationalization outcomes [80, 81].

4.5. Profile of Respondents and Firms

The final sample comprised 372 valid responses (Table 2), mainly from firms located in inland port-related regions of Hebei and Henan Provinces. Respondent characteristics included gender, age, education, and job position, while firm characteristics included size, age, and international business experience. These variables were reported only to describe the sample. The gender distribution was balanced, with 47.0% male and 53.0% female respondents. Most participants were aged 26–45 and held either a bachelor's degree or junior college qualification. Middle-level managers formed the largest group (48.1%), followed by senior managers or executives (19.6%) and logistics or supply chain staff (15.9%). Other respondents worked in international trade, marketing, sales, and business development. Most firms had 300 or more employees, and 75.5% had operated for 3–10 years. In addition, 76.6% had at least five years of international business experience, while only 6.2% had none. Overall, the sample included respondents and firms with relevant managerial, logistics, and international business experience, providing an appropriate basis for examining the effects of inland port innovation on firm internationalization.

Table 2
Profile of respondents and firms.

Variable	Category	Frequency	Percentage (%)
Gender	Male	175	47
	Female	197	53
Age	18–25	81	21.8
	26–35	125	33.6
	36–45	103	27.7
	46–55	31	8.3
	56–65	13	3.5
	65 or above	19	5.1
Education	High school or below	64	17.2
	Junior college	118	31.7
	Bachelor's degree	147	39.5
	Master's degree or above	43	11.6
Job position	Senior manager / executive	73	19.6
	Middle-level manager	179	48.1
	Logistics or supply chain staff	59	15.9
	International trade / import–export staff	23	6.2
	Marketing / sales / business development staff	9	2.4
	Other enterprise employees	29	7.8
Firm size	Fewer than 50 employees	11	3
	50–299 employees	74	19.9
	300–499 employees	173	46.5
	500 employees or above	114	30.6
Firm age	Less than 3 years	47	12.6
	3–5 years	95	25.5
	6–10 years	186	50
	More than 10 years	44	11.8
International business experience	No international business experience	23	6.2
	Less than 5 years	64	17.2
	5–10 years	189	50.8

Variable	Category	Frequency	Percentage (%)
	More than 10 years	96	25.8

5. Results

5.1. Preliminary Data Analysis

5.1.1. Descriptive Statistics

Descriptive statistics were calculated for the main constructs before conducting the measurement and structural model analyses. The score of each construct was obtained by averaging its three measurement items. As reported in Table 3, the mean values of the constructs were all higher than the midpoint of the five-point scale, indicating that the respondents generally reported positive perceptions of inland port innovation, supply chain cognition, institutional mechanisms, internationalization motivation, and internationalization outcomes.

Supply chain resilience cognition had the highest mean value (M = 3.955, SD = 0.968), followed by inland port operational model innovation (M = 3.951, SD = 1.069), normative institutional mechanism (M = 3.934, SD = 0.989), and regulative institutional mechanism (M = 3.911, SD = 1.028). These values suggest that firms in the sample were particularly aware of the role of inland ports in improving logistics reliability, operational services, and institutional support. The relatively high score of supply chain resilience cognition also indicates that many respondents perceived inland ports as helpful for stabilizing logistics activities and reducing uncertainty in international business operations.

By comparison, inland port institutional innovation reported the lowest mean value among the constructs (M = 3.345, SD = 0.953). This suggests that respondents' evaluations of institutional innovation were relatively more cautious than their evaluations of operational and logistics-related improvements. External internationalization motivation also showed a moderate mean value (M = 3.591, SD = 1.110), indicating that favorable inland port conditions may not automatically translate into strong external internationalization motivation for all firms.

The standard deviations ranged from 0.953 to 1.177, showing that the responses had sufficient variation across firms. This variation is useful for the following analyses because it indicates that the sample includes firms with different levels of perception, motivation, and internationalization outcomes. Therefore, the data provide an appropriate basis for subsequent CFA, SEM, and fsQCA analyses.

Table 3
Descriptive statistics of constructs.

Construct	Variable	Mean	SD
Inland Port Infrastructure Innovation	IPI	3.532	1.007
Inland Port Operational Model Innovation	OMI	3.951	1.069
Inland Port Institutional Innovation	INI	3.345	0.953
Supply Chain Resilience Cognition	SCRC	3.955	0.968
Logistics Cost Reduction Cognition	LCRC	3.597	1.105
Regulative Institutional Mechanism	RIM	3.911	1.028
Normative Institutional Mechanism	NIM	3.934	0.989
Cognitive Institutional Mechanism	CIM	3.783	1.050
External Internationalization Motivation	EIM	3.591	1.110
Internal Internationalization Motivation	IIM	3.698	1.177
Internationalization Outcomes	IO	3.684	1.117

5.1.2. Common Method Bias Test

Because the data were collected through a self-reported questionnaire, common method bias was examined before conducting the measurement and structural model analyses. Harman's single-factor test was performed using exploratory factor analysis without rotation. The results showed that the first unrotated factor explained 24.737% of the total variance, which was below the commonly recommended threshold of 50%. This result suggests that the variance in the data was not dominated by a single general factor. Therefore, common method bias was not considered a serious concern in this study. Nevertheless, because Harman's single-factor test is a diagnostic rather than definitive test, the possibility of same-source bias cannot be completely ruled out and is further acknowledged in the limitations section.

5.2. Measurement Model Assessment

5.2.1. Confirmatory Factor Analysis (CFA)

Before testing the structural relationships, confirmatory factor analysis (CFA) was conducted to assess the measurement model. The model included 11 first-order latent constructs: three dimensions of inland port innovation, two supply chain cognition variables, three institutional mechanisms, external and internal internationalization motivation, and internationalization outcomes. As shown in Table 4, the measurement model demonstrated a satisfactory fit. The χ^2/df ratio was below 3.0, while RMSEA was 0.043, indicating a good approximation to the data. All incremental fit indices exceeded 0.90: NFI = 0.931, IFI = 0.971, TLI = 0.965, and CFI = 0.971. Although the chi-square statistic was significant, this is common with relatively large samples and complex models. Overall, the combined fit indices confirm that the measurement model was acceptable for subsequent reliability, validity, and structural analyses.

Table 4
Model fit indices of the measurement model.

Fit index	Recommended Value	CFA result
χ^2/df	< 3.000	1.681
NFI	> 0.900	0.931
IFI	> 0.900	0.971
TLI	> 0.900	0.965
CFI	> 0.900	0.971
RMSEA	< 0.080	0.043
PCLOSE	> 0.050	0.987

Note: χ^2 = chi-square; df = degrees of freedom; NFI = normed fit index; IFI = incremental fit index; TLI = Tucker–Lewis index; CFI = comparative fit index; RMSEA = root mean square error of approximation; PCLOSE = p-value for close fit.

5.2.2. Assessment of Reliability and Convergent Validity

After confirming model fit, reliability and convergent validity were assessed using Cronbach's alpha, composite reliability (CR), standardized factor loadings, and average variance extracted (AVE).

As shown in Table 5, all factor loadings exceeded 0.60. IPI3 had the lowest loading (0.616) but remained above the acceptable threshold and was retained. Cronbach's alpha ranged from 0.800 to 0.949, while CR ranged from 0.799 to 0.950, indicating satisfactory internal consistency and reliability. AVE values ranged from 0.573 to 0.864, all exceeding 0.50.

Overall, the results confirm adequate reliability and convergent validity, supporting subsequent discriminant validity assessment and structural model testing.

Table 5
Reliability and convergent validity results.

Construct	Item	Standardized loading	Cronbach's α	CR	AVE
Inland Port Infrastructure Innovation	IPI1	0.827	0.800	0.799	0.573
	IPI2	0.810			
	IPI3	0.616			
Inland Port Operational Model Innovation	OMI1	0.934	0.949	0.950	0.864
	OMI2	0.941			
	OMI3	0.913			
Inland Port Institutional Innovation	INI1	0.772	0.853	0.855	0.664
	INI2	0.844			
	INI3	0.826			
Supply Chain Resilience Cognition	SCRC1	0.965	0.947	0.950	0.864
	SCRC2	0.946			
	SCRC3	0.875			
Logistics Cost Reduction Cognition	LCRC1	0.919	0.945	0.946	0.855
	LCRC2	0.988			
	LCRC3	0.862			
Regulative Institutional Mechanism	RIM1	0.875	0.884	0.888	0.725
	RIM2	0.787			
	RIM3	0.889			
Normative Institutional Mechanism	NIM1	0.752	0.844	0.845	0.646
	NIM2	0.819			
	NIM3	0.838			
Cognitive Institutional Mechanism	CIM1	0.916	0.934	0.934	0.825
	CIM2	0.895			
	CIM3	0.914			
External Internationalization Motivation	EIM1	0.849	0.921	0.924	0.803
	EIM2	0.972			
	EIM3	0.863			
Internal Internationalization Motivation	IIM1	0.901	0.947	0.948	0.858
	IIM2	0.912			
	IIM3	0.965			

Construct	Item	Standardized loading	Cronbach's α	CR	AVE
Internationalization Outcomes	IO1	0.908	0.938	0.938	0.835
	IO2	0.939			
	IO3	0.894			

5.2.3. Assessment of Discriminant Validity

Discriminant validity was assessed using the Fornell–Larcker criterion, which requires the square root of each construct's AVE to exceed its correlations with other constructs. As shown in Table 6, all diagonal values were higher than the corresponding inter-construct correlations. For example, the square roots of AVE for inland port infrastructure innovation and internationalization outcomes were 0.757 and 0.914, respectively, both exceeding their correlations with other constructs.

Moreover, no correlation exceeded 0.85. Although some constructs were relatively highly correlated, they remained empirically distinguishable. Overall, the results confirm adequate discriminant validity and support subsequent structural model testing.

Table 6
Discriminant validity.

Construct	IPI	OMI	INI	SCRC	LCRC	RIM	NIM	CIM	EIM	IIM	IO
IPI	**0.757**										
OMI	0.366	**0.930**									
INI	0.597	0.346	**0.815**								
SCRC	0.442	0.182	0.248	**0.930**							
LCRC	0.459	0.310	0.389	0.284	**0.925**						
RIM	0.629	0.292	0.461	0.406	0.364	**0.851**					
NIM	0.355	0.009	0.228	0.162	0.208	0.317	**0.804**				
CIM	0.096	0.085	0.099	0.089	-0.039	0.039	0.146	**0.908**			
EIM	0.288	0.107	0.265	0.144	0.132	0.253	0.262	0.166	**0.896**		
IIM	0.159	0.113	0.173	0.116	-0.004	0.217	0.293	0.254	0.381	**0.926**	
IO	0.163	0.128	0.199	0.098	0.086	0.160	0.189	0.173	0.345	0.477	**0.914**

5.2.4. Multicollinearity Assessment

Before conducting the structural model analysis, multicollinearity among the predictor variables was assessed using tolerance and variance inflation factor (VIF) values. Although the discriminant validity results had already shown that the constructs were empirically distinguishable, an additional multicollinearity check was conducted to ensure that the estimated structural paths were not affected by excessive overlap among the predictors. As shown in Table 7, all tolerance values were above the recommended minimum threshold of 0.10, ranging from 0.852 to 0.966. In addition, all VIF values were far below the commonly used threshold of 5.000, and also below the more conservative threshold of 3.300. Specifically, the VIF values ranged from 1.035 to 1.174, indicating a very low level

of multicollinearity among the predictor variables. Therefore, multicollinearity was not considered a serious concern in this study. The predictor variables provided sufficiently distinct explanatory information, and the data were suitable for subsequent structural model testing.

Table 7
Multicollinearity assessment.

Endogenous variable	Predictor variable	Tolerance	VIF
EIM	SCRC	0.930	1.076
EIM	LCRC	0.930	1.076
IIM	EIM	0.886	1.129
IIM	RIM	0.889	1.124
IIM	NIM	0.879	1.138
IIM	CIM	0.966	1.035
IO	EIM	0.852	1.174
IO	IIM	0.852	1.174

Note: VIF = variance inflation factor. Tolerance values above 0.10 and VIF values below 5.000 indicate that multicollinearity is not a serious concern.

5.3. Results of the Structural Model

After confirming the measurement model, the structural model was tested. The results indicated an acceptable fit: $\chi^2 = 975.722$, df = 479, $\chi^2/df = 2.037$, NFI = 0.910, IFI = 0.952, TLI = 0.947, CFI = 0.952, RMSEA = 0.053, and PCLOSE = 0.158. As shown in Table 8 and Fig. 2, infrastructure innovation significantly improved supply chain resilience cognition ($\beta = 0.442$, $p < 0.001$), supporting H1, while operational model innovation significantly enhanced logistics cost reduction cognition ($\beta = 0.321$, $p < 0.001$), supporting H2.

Supply chain resilience cognition positively affected external internationalization motivation ($\beta = 0.119$, $p < 0.05$), supporting H3a. However, logistics cost reduction cognition had no significant effect ($\beta = 0.098$, $p = 0.066$), so H3b was not supported. Institutional innovation significantly strengthened regulative ($\beta = 0.517$, $p < 0.001$) and normative institutional mechanisms ($\beta = 0.270$, $p < 0.001$), supporting H4a and H4b. Its effect on cognitive mechanisms was not significant ($\beta = 0.111$, $p = 0.054$), so H4c was not supported.

Normative ($\beta = 0.174$, $p < 0.01$) and cognitive institutional mechanisms ($\beta = 0.188$, $p < 0.001$) significantly improved internal internationalization motivation, supporting H5b and H5c. Regulative mechanisms had no significant effect ($\beta = 0.092$, $p = 0.079$), so H5a was not supported.

Finally, external motivation positively affected internal motivation ($\beta = 0.297$, $p < 0.001$), supporting H6. Both external motivation ($\beta = 0.192$, $p < 0.001$) and internal motivation ($\beta = 0.399$, $p < 0.001$) significantly improved internationalization outcomes, supporting H7 and H8. Internal motivation showed the stronger effect, highlighting the importance of firms' strategic willingness and readiness.

Table 8
Structural model results.

Hypothesis	Path	B	S.E.	C.R.	p-value	β	Result	p-value
H1	IPI → SCRC	0.474	0.067	7.098	< 0.001	0.442	Supported	***
H2	OMI → LCRC	0.319	0.052	6.099	< 0.001	0.321	Supported	***
H3a	SCRC → EIM	0.148	0.067	2.223	0.026	0.119	Supported	*
H3b	LCRC → EIM	0.095	0.052	1.838	0.066	0.098	Marginal, not supported	ns
H4a	INI → RIM	0.575	0.064	8.990	< 0.001	0.517	Supported	***
H4b	INI → NIM	0.305	0.068	4.477	< 0.001	0.270	Supported	***
H4c	INI → CIM	0.129	0.067	1.924	0.054	0.111	Marginal, not supported	ns
H5a	RIM → IIM	0.113	0.064	1.755	0.079	0.092	Marginal, not supported	ns
H5b	NIM → IIM	0.211	0.065	3.225	0.001	0.174	Supported	**
H5c	CIM → IIM	0.222	0.060	3.705	< 0.001	0.188	Supported	***
H6	EIM → IIM	0.356	0.061	5.874	< 0.001	0.297	Supported	***
H7	EIM → IO	0.201	0.054	3.743	< 0.001	0.192	Supported	***
H8	IIM → IO	0.350	0.046	7.654	< 0.001	0.399	Supported	***
Note: B = unstandardized coefficient; S.E. = standard error; C.R. = critical ratio; β = standardized coefficient.								

Note

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; ns = not significant.

5.4. Mediation Effect Analysis

To examine the indirect mechanisms, mediation analysis was conducted in AMOS using bootstrap estimation with bias-corrected 95% confidence intervals. An indirect effect was considered significant when the confidence interval excluded zero and the bootstrap p-value was below 0.05.

As shown in Table 9, infrastructure innovation significantly influenced external internationalization motivation through supply chain resilience cognition (β = 0.053, p = 0.047), whereas the indirect effect of operational model innovation through logistics cost reduction cognition was not significant (β = 0.031, p = 0.058).

Supply chain resilience cognition significantly affected internal internationalization motivation through external motivation (β = 0.035, p = 0.033), while logistics cost reduction cognition showed a weaker but significant indirect effect through the same pathway (β = 0.029, p = 0.049). Institutional innovation also had a significant total indirect effect on internal motivation through institutional mechanisms (β = 0.115, p = 0.002).

Finally, external motivation significantly affected internationalization outcomes through internal motivation (β = 0.119, p < 0.001). Normative and cognitive institutional mechanisms also had significant indirect effects through internal motivation, whereas the regulative mechanism did not. These results indicate that internal internationalization motivation is the key mediator linking logistics, institutional, and external motivational conditions to internationalization outcomes.

Table 9
Mediation effect analysis

Indirect path	Main mediating mechanism	Standardized indirect effect	95% CI Lower	95% CI Upper	p-value	Result
IPI → EIM	SCRC	0.053	0.001	0.119	0.047	Supported
OMI → EIM	LCRC	0.031	-0.001	0.073	0.058	Not supported
SCRC → IIM	EIM	0.035	0.003	0.082	0.033	Supported
LCRC → IIM	EIM	0.029	0.000	0.066	0.049	Weakly supported
INI → IIM	RIM / NIM / CIM	0.115	0.043	0.199	0.002	Supported
EIM → IO	IIM	0.119	0.063	0.190	< 0.001	Supported
SCRC → IO	EIM / IIM	0.037	0.002	0.087	0.039	Supported
LCRC → IO	EIM / IIM	0.030	-0.001	0.069	0.054	Not supported
INI → IO	Institutional mechanisms / IIM	0.046	0.018	0.083	0.001	Supported
RIM → IO	IIM	0.037	-0.008	0.088	0.111	Not supported
NIM → IO	IIM	0.070	0.025	0.127	0.001	Supported
CIM → IO	IIM	0.075	0.031	0.131	0.001	Supported

Note: Standardized indirect effects were estimated using bootstrap analysis with bias-corrected 95% confidence intervals. CI = confidence interval.

5.5. fsQCA Results

To complement the SEM results, fuzzy-set qualitative comparative analysis (fsQCA) was conducted to explore whether different combinations of conditions could lead to high internationalization outcomes. While SEM identifies the average net effects among variables, fsQCA is more suitable for examining causal complexity and equifinality. In other words, firms may achieve high internationalization outcomes through different pathways, rather than through one single linear mechanism. In this study, high internationalization outcomes (fsIO) were used as the outcome condition. To keep the configurational model parsimonious and avoid excessive limited diversity, seven theoretically central conditions were selected: inland port infrastructure innovation (fsIPI), inland port operational model innovation (fsOMI), inland port institutional innovation (fsINI), supply chain resilience cognition (fsSCRC),

logistics cost reduction cognition (fsLCRC), external internationalization motivation (fsEIM), and internal internationalization motivation (fsIIM).

5.5.1. Calibration and Necessary Condition Analysis

Before conducting fsQCA, all variables were calibrated into fuzzy-set membership scores. Since the original survey items were measured using a five-point Likert scale, this study adopted the direct calibration method. The threshold for full membership was set at 4.5, the crossover point was set at 3.0, and the threshold for full non-membership was set at 1.5. Cases with exact membership scores of 0.5 were adjusted to 0.501 to avoid ambiguity at the crossover point. After calibration, necessary condition analysis was conducted. A condition is usually considered necessary when its consistency exceeds 0.90. As shown in Table 10, none of the individual conditions reached this threshold. Among the presence conditions, supply chain resilience cognition showed the highest consistency value (0.865), followed by internal internationalization motivation (0.855) and operational model innovation (0.829). However, all values remained below 0.90. Similarly, none of the absence conditions reached the necessity threshold. These results indicate that high internationalization outcomes are not determined by any single condition alone. Rather, they are more likely to emerge from combinations of inland port innovation, firm cognition, and internationalization motivation. This finding supports the use of fsQCA for further sufficiency analysis.

Table 10
Necessary condition analysis for high internationalization outcomes

Condition	Consistency	RoN	Coverage
IPI	0.760	0.703	0.793
OMI	0.829	0.574	0.765
INI	0.709	0.769	0.811
SCRC	0.865	0.531	0.767
LCRC	0.754	0.687	0.782
EIM	0.803	0.724	0.824
IIM	0.855	0.705	0.836
~IPI	0.358	0.897	0.764
~OMI	0.269	0.936	0.784
~INI	0.419	0.869	0.761
~SCRC	0.232	0.945	0.779
~LCRC	0.357	0.902	0.773
~EIM	0.310	0.874	0.687
~IIM	0.243	0.866	0.605

Note: ~ indicates the absence of a condition. A condition is usually considered necessary when consistency exceeds 0.90. RoN = relevance of necessity.

5.5.2. Sufficiency Analysis and Configurational Pathways

After the necessary condition analysis, a truth table was constructed using a frequency threshold of 3 and a consistency threshold of 0.80. The intermediate solution was adopted as the main result. As shown in Table 11, four configurations were identified, with an overall solution consistency of 0.822 and coverage of 0.881, indicating acceptable consistency and strong explanatory power.

The first configuration, the resilience–internal motivation pathway, combines high supply chain resilience cognition with high internal internationalization motivation. This suggests that stable logistics perceptions and strong internal willingness jointly support high internationalization outcomes.

The second, the dual-motivation pathway, combines high external and internal internationalization motivation, highlighting the importance of aligning external opportunities with internal readiness.

The third, the operation–cost substitution pathway, combines high operational model innovation, weak institutional innovation, and high logistics cost reduction cognition. This indicates that operational efficiency and cost advantages may compensate for weaker institutional support.

The fourth, the integrated logistics–motivation pathway, combines high infrastructure innovation, operational model innovation, supply chain resilience cognition, logistics cost reduction cognition, and external internationalization motivation. This reflects a comprehensive mechanism in which infrastructure, services, logistics perceptions, and external motivation jointly reinforce internationalization outcomes.

Table 11
Configurations leading to high internationalization outcomes

Conditions	C1	C2	C3	C4
IPI				●
OMI			●	●
INI			⊗	
SCRC	●			●
LCRC			●	●
EIM		●		●
IIM	●	●		
Consistency	0.858	0.873	0.860	0.887
PRI	0.824	0.839	0.775	0.847
Raw coverage	0.765	0.723	0.299	0.494
Unique coverage	0.092	0.057	0.016	0.020
Solution consistency	0.822			
Solution PRI	0.783			
Solution coverage	0.881			

Note: ● indicates the presence of a condition; ⊗ indicates the absence of a condition; blank spaces indicate that the condition is irrelevant to the configuration. PRI = proportional reduction in inconsistency. C1 = resilience–internal motivation pathway; C2 = dual-motivation pathway; C3 = operation–cost substitution pathway; C4 = integrated logistics–motivation pathway.

5.5.3. Robustness Check

To test sensitivity to threshold settings, a robustness check (Table 12) increased the consistency threshold from 0.80 to 0.85 while retaining the frequency threshold of 3. The same four configurations emerged: the resilience–internal motivation, dual-motivation, operation–cost substitution, and integrated logistics–motivation pathways. This confirms that the fsQCA results are stable under a stricter consistency threshold. Their complementarity with the SEM findings is discussed in Section 6.

Table 12
Robustness check of fsQCA results.

Robustness setting	Frequency threshold	Consistency threshold	Result
Main analysis	3	0.80	Four configurations identified
Robustness check	3	0.85	Same four configurations identified

Note: The robustness check confirms that the fsQCA solution is stable after increasing the consistency threshold from 0.80 to 0.85.

6. Discussion and conclusions

6.1. Discussion of Findings

6.1.1. Cognitive Effects of Inland Port Innovation

The findings show that inland port innovation affects firm internationalization through cognitive, institutional, and motivational mechanisms. SEM identifies the main net effects, while fsQCA reveals multiple pathways to high internationalization outcomes. Infrastructure innovation significantly strengthens supply chain resilience cognition by improving reliability, transport continuity, and supply chain security. Operational model innovation enhances logistics cost reduction cognition through service integration, process simplification, and coordination efficiency. These results are consistent with research emphasizing the role of inland ports in improving hinterland connectivity, multimodal transport, logistics services, and supply chain resilience [38, 44, 47, 62]. However, logistics cost reduction cognition does not significantly affect external internationalization motivation. Although lower logistics and coordination costs reduce transaction barriers [41], internationalization also requires market knowledge, strategic readiness, networks, and managerial confidence [14, 20, 51]. Cost advantages may therefore support internationalization without independently triggering it, as firms must also perceive broader international opportunities [16, 20].

6.1.2. Institutional Mechanisms and Boundary Conditions

Institutional innovation significantly strengthens regulative and normative mechanisms, but its effect on cognitive mechanisms is marginal. Formal changes, including customs facilitation, policy coordination, administrative procedures, and service standards, are quickly recognized by firms [29, 31]. Cognitive mechanisms, by contrast, involve shared understanding, knowledge, and legitimacy, which develop gradually through learning, repeated use, communication, and trust [30, 33]. Normative and cognitive mechanisms significantly enhance internal internationalization motivation, whereas regulative mechanisms do not. Formal policy support alone may therefore be insufficient to create strategic willingness. Firms become more motivated when internationalization is regarded as a legitimate, accepted, and understandable path [30, 42, 43]. These unsupported paths indicate important boundary conditions. Lower costs, formal regulation, and cognitive development do not automatically generate internationalization motivation [16, 17, 20]. International expansion also requires opportunities, risk tolerance, knowledge, normative encouragement, strategic readiness, and internal resource commitment [14, 20, 29, 30, 31, 33].

6.1.3. External–Internal Motivation Transformation

External internationalization motivation significantly strengthens internal motivation, and both improve internationalization outcomes. Internal motivation has the stronger direct effect, indicating that regional opportunities must be transformed into firm-level commitment, strategic intention, and resource allocation before producing stronger performance [14, 16, 20, 37]. This result is consistent with research showing that international performance depends on both external opportunities and firms' strategic capabilities and resource mobilization [67, 68, 70, 82]. The mediation results further confirm that external motivation improves internationalization outcomes partly by strengthening internal strategic action.

6.1.4. Configurational Pathways to Internationalization Outcomes

The fsQCA results identify four pathways to high internationalization outcomes [21, 76, 80]. First, the resilience–internal motivation pathway combines supply chain reliability with strong internal commitment [27, 48]. Second, the

dual-motivation pathway shows that external opportunities are most effective when accompanied by internal readiness [20, 51]. Third, the operation–cost substitution pathway indicates that operational innovation and logistics cost reduction can generate high outcomes even without strong institutional innovation [16]. This explains why cost reduction was insignificant in SEM but appeared in fsQCA: its influence is configurational rather than independently linear. Fourth, the integrated logistics–motivation pathway combines infrastructure innovation, operational innovation, resilience cognition, cost reduction cognition, and external motivation [16, 20, 27, 48]. It shows that internationalization is strengthened when physical infrastructure, logistics services, firm cognition, and motivation operate jointly. Overall, SEM identifies key net-effect relationships, while fsQCA demonstrates that different combinations can produce the same outcome [21, 76, 80]. Inland port innovation therefore influences internationalization through both linear mechanisms and multiple equivalent causal configurations [37, 76].

6.2. Theoretical Contributions

This study extends inland port research beyond infrastructure, connectivity, and logistics efficiency by explaining how firms interpret and use inland port innovation for internationalization [3, 5, 20, 34, 38]. It distinguishes infrastructure innovation from operational model innovation, showing that they influence firm cognition and internationalization motivation through different mechanisms [44, 45, 47, 48]. The study also differentiates the regulative, normative, and cognitive dimensions of institutional innovation [29, 30]. This perspective shows that internationalization depends not only on formal support but also on whether firms perceive it as legitimate and understandable. Moreover, distinguishing external from internal internationalization motivation explains how regional advantages are converted into strategic willingness and firm outcomes [14, 20]. Methodologically, combining SEM and fsQCA captures both net effects and alternative causal configurations, making it suitable for examining interdependent, asymmetric, and equifinal regional development processes [21, 76].

6.3. Practical Implications

Inland port managers should complement infrastructure investment with digital logistics platforms, coordinated customs clearance, multimodal transport, and integrated supply chain services [2, 5, 38, 45]. These services can reduce operational complexity and facilitate cross-border activities. Local governments should move beyond regulatory and administrative support by providing trade standards, export guidance, international business training, market information, and knowledge-sharing services [17, 31, 33, 45]. These measures can strengthen firms' normative and cognitive readiness for internationalization. Firms should regard inland ports as strategic resources for improving logistics reliability, reducing coordination costs, accessing information and partners, and accelerating international market entry [2, 5]. They should also strengthen internal motivation, international strategies, resource commitment, and cross-border management capabilities [14, 20]. Because the fsQCA results identify multiple pathways, policy support should be tailored to firms' conditions rather than follow a single model. Depending on their capabilities and institutional environments, firms may rely on resilience, operational innovation, cost advantages, motivation, or integrated logistics support [21, 76].

6.4. Limitations and Future Research

First, the cross-sectional design limits causal inference. Longitudinal studies could examine changes following infrastructure upgrades, customs reforms, or service innovation [83]. Second, the study relies on self-reported data. Future research could incorporate export volumes, customs clearance time, logistics costs, overseas partnerships, and inland port usage, as well as marker variables, multi-source data, or time-lagged designs [75, 84]. Third, internationalization outcomes were modeled as a first-order construct. Future studies could examine network expansion, internationalization speed, and trade growth separately or as higher-order dimensions [34, 37, 85].

Fourth, the sample was concentrated in selected regions of Hebei and Henan. Comparative studies across railway hubs, border ports, bonded zones, coastal-linked ports, and cross-border e-commerce centers could test the generalizability of the findings [3, 5]. Finally, future fsQCA studies should examine configurations producing low internationalization outcomes to determine whether they follow distinct causal patterns [21, 76, 80].

6.5. Conclusion

This study developed a hybrid SEM–fsQCA framework to explain how inland port innovation affects firm internationalization [21, 80]. Infrastructure innovation strengthened supply chain resilience cognition, while operational model innovation improved logistics cost reduction cognition. Resilience cognition enhanced external motivation, whereas cost reduction cognition did not. Institutional innovation strengthened regulative and normative mechanisms, but only normative and cognitive mechanisms significantly promoted internal motivation. Both motivational dimensions improved internationalization outcomes, with internal motivation exerting the stronger effect [20, 29].

The fsQCA results identified four pathways: resilience–internal motivation, dual motivation, operation–cost substitution, and integrated logistics–motivation [21, 48]. Thus, inland port innovation operates through both linear relationships and multiple configurations involving logistics conditions, institutional mechanisms, firm cognition, and strategic motivation [5, 27].

Overall, inland ports function not only as logistics nodes but also as regional platforms supporting industrial internationalization [5]. By integrating logistics innovation, institutional mechanisms, cognition, and motivation, this study clarifies how inland ports facilitate the international development of surrounding firms [20, 27, 29, 48].

Declarations

Informed consent to participate

Informed consent for participation was obtained from all respondents who participated in the survey. No data were collected from anyone under 18 years old.

Consent to publish

All authors approved the manuscript and gave their consent for submission and publication.

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Data Availability

The datasets, survey questionnaire, variable codebook, and analytical outputs supporting the findings of this study are provided as Supplementary Materials for peer review. These materials will be made publicly available upon publication.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Figures

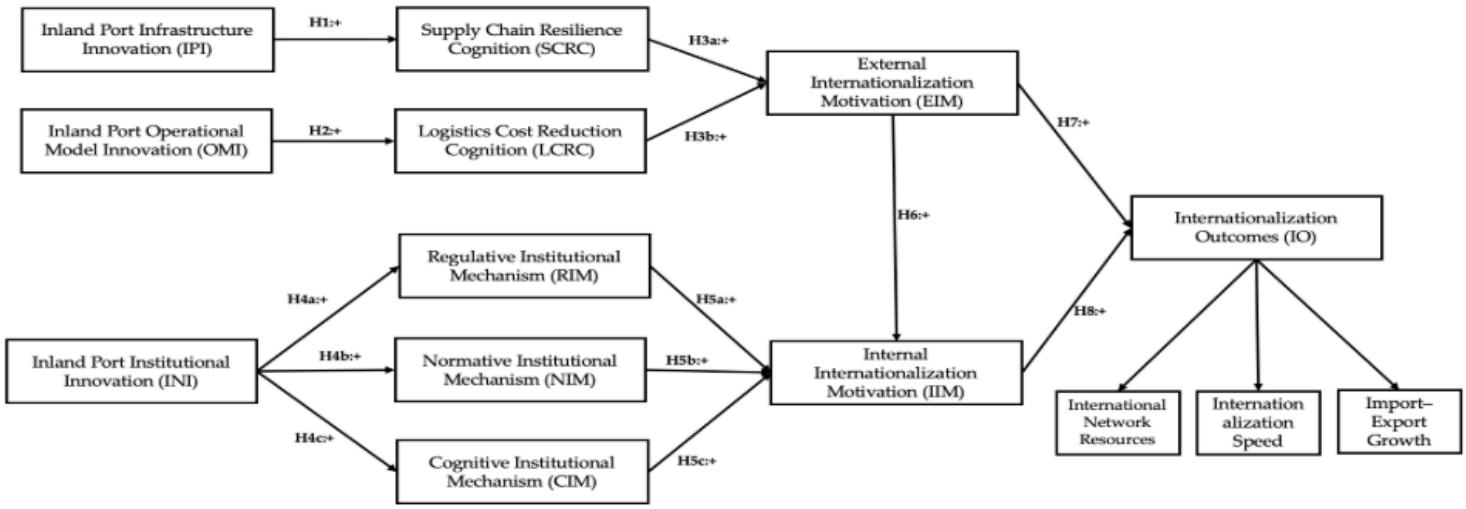


Figure 1

Research model

Note: IPI = Inland Port Infrastructure Innovation; OMI = Inland Port Operational Model Innovation; INI = Inland Port Institutional Innovation; SCRC = Supply Chain Resilience Cognition; LCRC = Logistics Cost Reduction Cognition; RIM = Regulative Institutional Mechanism; NIM = Normative Institutional Mechanism; CIM = Cognitive Institutional Mechanism; EIM = External Internationalization Motivation; IIM = Internal Internationalization Motivation; IO = Internationalization Outcomes.

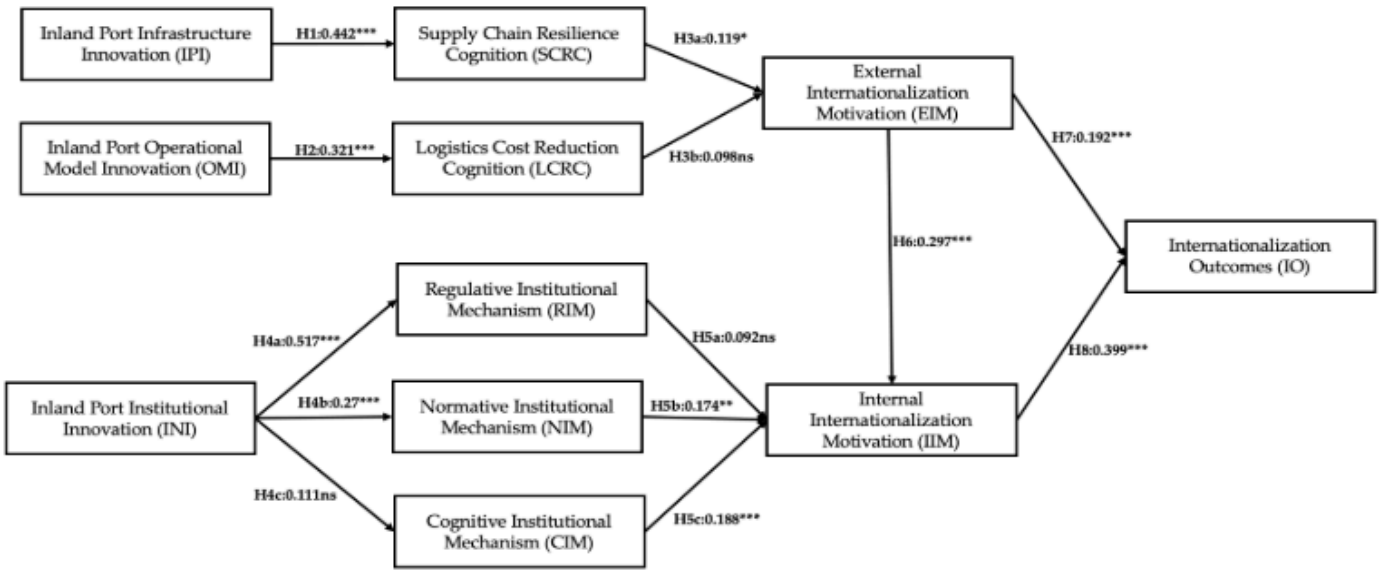


Figure 2

Structural equation model (SEM) results.

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; ns = not significant.

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