

A Study on Digital Supply Chain Optimization for Zhanjiang Aquatic Products under the Sino-US Trade War

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Abstract: The ongoing Sino-US trade tariff war poses severe challenges to Chinas aquatic industry, which is oriented towards exports to the US. Zhanjiang, as the nations largest processing and export base for farmed shrimp and a major production area for shellfish, is facing a triple pressure of shrinking export markets, cost inversions, and insufficient resilience of traditional supply chains. This paper constructs a theoretical analysis framework of "Institutional Pressure—Supply Chain Response—Value Reconstruction" to systematically dissect the transmission mechanisms of tariff shocks and the pathways of digital adaptation within Zhanjiangs aquatic product supply chain. Based on an in-depth analysis of three typical cases—the policy instruments of Zhanjiang Customs, the China Oyster Capital Industrial Internet Platform, and the Quanlian Jicai Smart Cold Chain Logistics Park—this study finds that digital supply chain optimization achieves a paradigm shift from "passively bearing tariffs" to "actively defining value" through three pathways: deconstructing singular tariff risks via market diversification, reshaping the distribution of trade gains through transparent price formation mechanisms, and building capabilities to counter non-tariff barriers via full-chain traceability. The research further proposes a three-dimensional optimization framework encompassing the construction of an industry-level digital ecosystem, the upgrading of enterprise-level technology adoption, and the adaptation of the policy-level institutional environment. This reveals that digitalization is not merely an efficiency tool, but a new type of strategic asset for restructuring the distribution of power in the global aquatic value chain amidst trade wars. This study provides a theoretical explanation for the digital transformation of traditional industries under the strain of trade friction and offers practical reference for building supply chain resilience in other export-oriented agricultural production areas.

Keywords: Sino-US Trade War; Zhanjiang Aquatic Products; Digital Supply Chain; Tariff Transmission Mechanism; Industrial Internet Platform.

1. Introduction

In 2025, the global aquatic trade landscape is undergoing a profound restructuring. The Sino-US trade friction, ongoing since 2018, has led to the imposition of a 25% tariff on Chinese aquatic products by the United States. This tariff has not been fully passed on to American importers; rather, it has profoundly reshaped the operational logic of Chinese aquatic product export enterprises through price transmission mechanisms.[1] Recent econometric research from Mississippi State University indicates that the 25% ad valorem tariff implemented since 2019 has been primarily absorbed by Chinese exporters through price reductions, resulting in significantly lower actual settlement prices for products like crawfish and oysters exported to the US compared to pre-tariff war levels.[2] Concurrently, Chinas overall aquatic products industry has shifted from a phase of rapid expansion into a new development stage characterized by "low growth, low investment, and a quest for stability," with enterprises generally adopting prudent operational strategies focused on scaling back and slowing down.[3]

Zhanjiang, a coastal city acclaimed as "Chinas Shrimp Capital," lies at the epicenter of this structural pressure. As the nations largest base for farmed shrimp processing and export, Zhanjiangs aquatic product export value has long ranked among the top prefecture-level cities nationally, with a high degree of dependence on the US market. However, the ripple effects triggered by the tariff war extend far beyond the export link.[4] As export channels for US-dependent varieties like

tilapia and shrimp constrict, substantial production capacity originally destined for exports is being forced to pivot to the domestic market, intensifying competition alongside imported aquatic products in an already fiercely competitive domestic arena. A more profound predicament lies in the fact that the long-standing structural problems of the traditional aquatic product supply chain—such as fragmented business entities, opaque transaction information, difficulties in quality traceability, and inadequate cold chain supporting facilities—are acutely magnified when external demand contracts.[5]

It is precisely against this backdrop that Zhanjiangs aquatic industry has recently initiated a series of intensive digitalization-centric supply chain optimization practices. In 2024, Zhanjiang Customs issued "Twenty Measures," explicitly stating goals to "enhance the intelligence level of port informatization" and "explore an integrated smart supervision model for ports and zones." In June 2025, the Quanlian Jicai Cold Chain Logistics Park, with an investment of 920 million yuan, was completed and commenced operations, aiming to build an RCEP regional cold chain hub under the model of "sharing economy + industrial empowerment." By the end of the same year, the China Oyster Capital Industrial Internet Platform in Xiashan District completed its trial operation, establishing a digital resource pool and full lifecycle data traceability covering over 1 million mu of farming area. These practices are not isolated technological upgrades; they represent a systemic rethinking and reconstruction of the traditional supply chain paradigm, forced upon the entire industry by the impact of tariffs.[6]

However, existing academic research has yet to adequately respond to this important phenomenon theoretically. Some literature focuses on the application prospects of blockchain in the aquatic product supply chain but remains largely at the level of technical functional descriptions. While rigorous in their empirical analysis of tariff transmission mechanisms within the field of international trade, such studies often fail to delve deeply into the internal strategic response behaviors of enterprises within the industrial chain. [7] Discussions on the digitalization of agricultural supply chains in agro-economic research are rarely examined within the specific context of institutional pressure stemming from major-country trade frictions. This study aims to fill this gap. Its core research question is: Under the sustained pressure of the Sino-US trade tariff war, what unique pathways does the digital optimization of Zhanjiangs aquatic product supply chain exhibit? How do its optimization mechanisms counteract tariff shocks? What theoretical implications does this practice hold for understanding the digital transformation of traditional industries in the context of trade friction?

The theoretical contributions of this paper are threefold. First, it integrates the analysis of tariff transmission mechanisms with research on digital supply chain transformation, constructing an "Institutional Pressure—Supply Chain Response—Value Reconstruction" analytical framework that reveals the mediating mechanisms through which trade policy shocks transmit to industrial micro-practices.[8] Second, based on the Zhanjiang case, it distills three core pathways of digital supply chain optimization—market diversification, price transparency, and traceability systematization—and interprets these as a paradigm shift from "passively bearing tariffs" to "actively defining value." Third, it proposes a three-dimensional optimization framework comprising the industry-level digital ecosystem, enterprise-level technology adoption, and policy-level institutional environment adaptation, offering testable theoretical propositions for subsequent research.

The remainder of this paper is structured as follows: Section 2 provides a literature review and outlines the analytical framework; Section 3 details the research design and case selection; Section 4 presents the analysis of three typical cases of digital supply chain optimization in Zhanjiang; Section 5 offers theoretical explanations and proposes optimization pathways; Section 6 presents the conclusions and policy implications.

2. Literature Review and Analytical Framework

2.1. Tariff Transmission Mechanisms and Aquatic Product Trade: From Macro Effects to Industrial Impact

A relatively systematic body of quantitative evidence has accumulated on the impact of the Sino-US trade war on aquatic product trade. In a series of studies based on NOAA fisheries import data from 1989 to 2025, scholar Posadas from Mississippi State University found that the 25% tariff imposed by the US on Chinese crawfish and oyster products since 2018 has been primarily borne by Chinese exporters through price reductions. Consequently, the market share of Chinese crawfish in the US dropped from 86% in 2018 to 65% in 2024, and the share of oysters plummeted from 41.3% to 19.3%. This finding challenges the simplified assumption in

classical trade theory that "importing country tariffs are borne by importers," revealing that, within the division of labor in global value chains, exporting country suppliers in a weaker bargaining position often become the de facto bearers of tariffs. [9]

Cui He (2025) revealed the differentiated characteristics of the tariff impact at a more macro level. Prices for varieties highly dependent on US exports, such as tilapia and shrimp, have continued to decline, severely compressing profit margins in the farming segment. Conversely, prices for varieties primarily targeting the domestic market, like large yellow croaker and sea bass, have remained stable or even increased. This differentiation indicates that the tariff shock is not uniformly distributed across the entire industry but is transmitted differentially along the supply chain according to the degree of export orientation. However, existing research mostly stops at identifying the existence and distributional characteristics of the shock, paying scant attention to the internal decision-making mechanisms of how enterprises respond to this shock. Do enterprises simply choose between passively bearing the cost or actively exiting the market? Or is there a third path—restructuring the tariff-bearing capacity through supply chain transformation? This is precisely the question this study seeks to answer.

2.2. Digitalization of Agricultural Supply Chains: Tension between Efficiency Logic and Institutional Logic

Research on the digitalization of agricultural supply chains has formed a relatively mature theoretical accumulation. Early literature focused on the application value of technologies such as the Internet of Things (IoT), big data, and blockchain in functional areas like traceability management, inventory optimization, and demand forecasting, adhering to a typical functionalist paradigm of "technology adoption—efficiency improvement." In recent years, some scholars have begun to examine the reshaping effects of digital technology on power relations within agricultural value chains, such as platforms empowering smallholders and price transparency dissolving intermediary information rents, reflecting a paradigm expansion from efficiency logic to institutional logic.

However, existing research still exhibits two significant blind spots. First, most literature treats digital supply chain construction as an autonomous enterprise decision for internal efficiency optimization, rarely situating it within the context of external institutional pressures (such as tariff wars, technology blockades, and supply chain decoupling) that act as a forcing mechanism. Second, there is a notable lack of attention to the specific category of aquatic products. Compared to other agricultural products like fruits, vegetables, and livestock, aquatic products possess unique attributes such as freshness and perishability, cold chain dependency, and complex import/export quarantine standards. The technical thresholds and institutional constraints for their supply chain digitalization are considerably higher than for other categories. Zhanjiang, with its dual identity as an export-oriented hub and a producer of specialty aquaculture products, provides an ideal field setting to investigate these issues.

2.3. Theoretical Framework: Institutional Pressure, Supply Chain Response, and Value Reconstruction

Integrating the above literature streams, this paper proposes the "Institutional Pressure—Supply Chain Response—Value Reconstruction" analytical framework (Figure 1) as a theoretical lens for understanding the digital optimization of Zhanjiang's aquatic product supply chain amidst the Sino-US trade war.

Dimension of Institutional Pressure. The Sino-US trade tariff war is fundamentally a structural in the external institutional environment. Distinct from normal market fluctuations, the tariff war possesses three characteristics: persistence (ongoing since 2018), unpredictability (frequent adjustments in tax rates and lists of taxable goods), and asymmetry (the primary tax burden borne by Chinese exporters). This institutional pressure enters the supply chain system through three pathways: price transmission, order diversion, and expectation perturbation.

Dimension of Supply Chain Response. Digital supply chain optimization is not a routine enterprise technology upgrade investment but a strategic response to institutional pressure. This paper distinguishes three types of digital response models: (1) Market-connecting response—breaking the physical boundaries of traditional wholesale markets through industrial internet platforms, enabling multi-polar direct connections between production areas and sales destinations; (2) Price-discovery response—aggregating authentic transaction data through closed-loop digital transactions to generate industrial indices and price signals reflecting real supply and demand; (3) Quality-certification response—transforming "traceability" into quality certification assets capable of countering international non-tariff barriers through full lifecycle traceability systems.

Dimension of Value Reconstruction. The deep-seated goal of the aforementioned responses is not localized efficiency improvement but a systemic reshaping of the value distribution pattern within the supply chain. Specifically, it represents a transition from the role of a price taker who passively bears tariffs to a value co-creator who actively defines value. This transformation encompasses three levels: shifting from single market dependence to multi-polar market equilibrium; moving from information opacity to price discovery capability; and evolving from compliance-oriented traceability to differentiated competitive advantage.

3. Research Design and Case Selection

This study adopts a multi-case study method, primarily based on three considerations: First, digital supply chain optimization is a complex socio-technical process occurring within specific spatiotemporal contexts; case studies facilitate capturing its dynamic evolution and contextual dependencies. Second, Zhanjiang's aquatic industry concurrently exhibits three distinct digitalization pathways—government-led, state-owned enterprise-led, and private enterprise-led; case comparison helps identify theoretical logics behind similarities and differences. Third, existing theory lacks mature hypotheses regarding agricultural supply chain digitalization under trade war conditions, making case studies suitable for theory building rather than hypothesis testing.

Case selection follows the principle of "theoretical sampling," balancing typicality and Differences. Zhanjiang Customs Twenty Measures represent digital policy tools on

the institutional supply side, reflecting government-led digital empowerment in customs supervision, port clearance, and AEO certification. The China Oyster Capital Industrial Internet Platform represents an industrial agglomeration and digital ecosystem construction initiative led by local state-owned enterprises, focusing on domestically-oriented specialty aquatic products. The Quanlian Jicai Cold Chain Logistics Park represents a cross-border cold chain digital hub led by a leading enterprise, focusing on import and re-export trade. These three cases cover three types of digitalization carriers—policy, platform, and infrastructure—and span three business models—export-to-domestic pivot, specialty domestic sales, and cross-border hub—constituting a complete evidence triangle.

Data sources include three categories: (1) government documents and policy texts (Zhanjiang Customs announcements, Xiashan District government work briefings); (2) authoritative media reports (in-depth coverage of relevant projects by outlets such as Yangcheng Evening News and The Beijing News); (3) third-party research literature (academic papers, industry association reports). A three-level coding strategy was employed for structured analysis of qualitative data to enhance research reliability.

4. Three Pathways of Digital Supply Chain Optimization for Zhanjiang Aquatic Products

4.1. Digitalization of Institutional Supply: Smart Customs Supervision and Trade Facilitation Empowerment

The core characteristic of Zhanjiang Customs "Twenty Measures" issued in October 2024 lies in embedding digital transformation at the institutional supply level of trade governance. Unlike previous customs policies focused primarily on "cost reduction" and "process simplification," these measures explicitly list "enhancing the intelligence level of port informatization" as an independent policy section, parallel to traditional sections like promoting logistics efficiency and reducing enterprise costs. This marks a critical shift where policymakers have elevated digitalization from an auxiliary tool to a governance paradigm.

Among the specific measures, two institutional innovations with breakthrough significance stand out: one is the digital scheduling capability for integrating and optimizing route resources under the "parallel port" logistics model; the other is the exploration of an "integrated port-zone" smart supervision model within comprehensive bonded zones. The former dismantles logistics information barriers between the Guangdong-Hong Kong-Macao Greater Bay Area and Hainan Free Trade Port through multimodal transport information sharing, while the latter extends customs supervision space from physical fences to digital fences. Viewed through the lens of tariff response, the institutional implication of these measures is that: when export markets are obstructed by tariff barriers, supply chain agility becomes a critical support for enterprises switching markets and adjusting orders. Every 1% increase in customs clearance timeliness proportionally enhances enterprises response elasticity to overseas order fluctuations.

Furthermore, while the policy of "promoting the deduction of domestic freight costs for the Western Land-Sea New Corridor rail-sea intermodal transport" is fundamentally a

cost policy, its implementation heavily relies on digitalized cost breakdown and responsibility allocation across logistics segments. This reveals a frequently overlooked theoretical proposition: the value of digitalization lies not only in efficiency improvement but also in the refined decomposition of costs and precise attribution of responsible entities—it is precisely this "decomposability" that grants enterprises flexible arbitrage opportunities amidst complex trade rules.

4.2. Digitalization of Industrial Platforms: The "Digital Metamorphosis" Path of China Oyster Capital

If the Customs measures represent top-down institutional empowerment, the practice of the China Oyster Capital Industrial Integration Development Demonstration Zone in Xiashan District represents bottom-up industrial ecosystem reconstruction. Zhanjiangs oyster industry produces over 400,000 tons annually with an output value of 7 billion yuan, yet has long suffered from three chronic ailments: fragmented operations, poor information flow, and low added value. Over 50 processing individual businesses operated "like a sheet of loose sand," causing peak-season traffic congestion and off-season desolation. More critically, a substantial volume of transaction data remained trapped in gray areas, preventing the industry's true value from being fully reflected in statistical accounting.

The breakthrough of the China Oyster Capital Industrial Internet Platform lies in the fact that it is not merely a simple B2B e-commerce website, but an institutional infrastructure for rebuilding industrial trust through digital contracts. By recording full lifecycle data of oysters—from seedling cultivation, farming, harvesting, transportation, cleaning, sorting, purification, packaging, cold chain, to sales—the platform integrates fragmented information scattered across thousands of farmers, dozens of processing enterprises, and hundreds of distributors into a "digital resource pool covering over 1 million mu of farming area." More importantly, the platform generated two novel assets previously absent from Zhanjiangs oyster industry: the Oyster Industry Digital Map and the Oyster Industry Index.

The value of these two assets becomes particularly prominent in the context of the tariff war. One key reason for the weak bargaining power of traditional aquatic product export enterprises when facing overseas customers is the lack of authoritative third-party price indices to serve as quotation benchmarks. With the China Oyster Capital platform beginning to aggregate real-time transaction, logistics, and capital flow data across the industrial chain, Zhanjiang oysters have, for the first time, acquired a verifiable price discovery mechanism. This not only serves precise matching in the domestic market (e.g., the origin-direct supply cooperation with Chengdu Market operated by Shenzhen Agricultural Power Group) but also implies strategic reserves for future responses to international non-tariff barriers: a traceable, quantifiable, auditable digital industrial infrastructure is precisely the core foundational capability for coping with increasingly stringent import compliance scrutiny of aquatic products by developed countries.

4.3. Digitalization of Cold Chain Infrastructure: The Hub Empowerment Logic of Quanlian Jicai

The Quanlian Jicai Cold Chain Logistics Park, operational

since June 2025, represents the third pathway of digital supply chain optimization—upgrading physical infrastructure through intelligence, embedding digital service capabilities, thereby restructuring the regional allocation pattern of global aquatic resources. This pathway exhibits a clear functional differentiation from customs institutional supply and industrial internet platforms: the former focuses on the institutional soft environment, the latter on the industrial middle platform, while the cold chain logistics park concentrates on the composite entity of "hard infrastructure + soft services."

The projects core competitiveness statement is quite telling: "Cold storage fees are lower than the external transportation costs of agricultural and aquatic products." This slogan embodies typical platform pricing logic—pricing is not based on the marginal cost of cold storage operation, but on the transaction cost of alternative solutions. When the idle rate of enterprise self-built cold storage is high and the information search cost for third-party cold storage is substantial, Quanlian Jicai, through digital tools such as shared warehousing, dynamic inventory management, and trunk network optimization, compresses unit logistics costs to less than one-third of traditional models. The embedding of IoT and AI algorithms enables temperature control accuracy within the 150,000-ton cold storage cluster to not exceed $\pm 0.5^{\circ}\text{C}$, while inbound/outbound efficiency increases by 300%.

More strategically significant is its hub positioning of "global sourcing, global sales." The park has already connected with over 600 member enterprises across 120 countries, with annual imports exceeding 4 billion yuan. Three signed agreements during the inauguration—SF Express cold chain charter flights directly serving RCEP countries, China Construction Bank providing 2 billion yuan in supply chain finance credit lines, and 15 overseas suppliers establishing forward warehouses—clearly delineate Zhanjiangs trajectory from an "aquatic product export base" to a "global aquatic resource allocation hub." In the context of the ongoing tariff war and the constricted US export channel, the industrial logic behind this leap is: rather than repeatedly grappling with tariffs in a single export market, it is preferable to transform oneself into a regional distribution center for global aquatic resources, converting tariff risks into hub dividends.

5. Theoretical Explanation: How Digitalization Counteracts Tariff Shocks

Synthesizing the analysis of the three case studies above, this paper proposes three core mechanisms through which digital supply chain optimization counteracts tariff shocks, thereby revealing its deeper theoretical implications.

Mechanism 1: Market Diversification Deconstructs Singular Tariff Risk

The traditional Zhanjiang aquatic product supply chain exhibited a distinct "production area aggregation—export orientation" characteristic, with heavy dependence on the US market. The primary contribution of digital optimization lies in reducing transaction costs for market switching. The China Oyster Capital platform standardizes production area information, inventory status, quality grading and other data, interfacing them in real-time with 35 market nodes across the country under Shenzhen Agricultural Power Group. This

compresses sales channel development, which previously required months, into a matter of weeks. Quanlian Jicai cross-border cold chain network incorporates fresh supply from 15 RCEP countries into Zhanjiangs resource allocation radius. The theoretical essence of this mechanism is: by lowering information barriers to market diversification, digitalization reshapes enterprises from "tariff bearers" into "market choosers."

Mechanism 2: Transparent Price Formation Reshapes Trade Gain Distribution

The empirical finding that Chinese exporters primarily bear the 25% tariff reveals a long-overlooked structural issue: despite Chinas scale advantage in aquatic product exports, the absence of pricing discourse power has historically placed it at a disadvantage in the distribution of trade gains. Digital supply chains intervene in this problem not through direct price increases, but by constructing credible price discovery mechanisms via industrial internet platforms. When the "Oyster Industry Index" begins to be incorporated as a reference benchmark by an increasing number of buyers, Zhanjiang oysters have taken a crucial step from passively accepting buyer quotes to participating in price formation. The theoretical implication of this mechanism is: the deep value of supply chain digitalization is not raising absolute prices, but reshaping the capability configuration of bargaining positions.

Mechanism 3: Full-Chain Traceability Builds Capacity to Counter Non-Tariff Barriers

Alongside the ongoing Sino-US trade war, technical barriers to trade (such as increasingly stringent hygiene and quarantine standards for seafood imports, traceability certification, and carbon footprint requirements) are becoming more subtle yet more challenging obstacles than tariffs. Zhanjiang Customs AEO certification cultivation, the China Oyster Capital platforms full lifecycle data recording, and Quanlian Jicai fully traceable temperature control collectively constitute a digital capability reserve for addressing non-tariff barriers. The unique aspect of this mechanism is: it transforms traceability requirements, originally a compliance cost, into market-verifiable quality signals—whereby "traceability" itself becomes a source of product differentiation value creation.

Collectively, these three mechanisms point toward a deeper theoretical judgment: Under the institutional pressure of the Sino-US trade war, the digital optimization of Zhanjiangs aquatic product supply chain is undergoing a paradigm shift from "efficiency improvement" to "value reconstruction." The narrative of traditional supply chain digitalization revolves around cost reduction, efficiency enhancement, loss minimization, and inventory optimization—these remain important objectives, but they are insufficient to explain the strategic orientation of Zhanjiangs practices. When the China Oyster Capital platform strives to define industry standards, when Quanlian Jicai aims to become an RCEP regional cold chain hub, when Zhanjiang Customs explores "integrated port-zone" smart supervision, the common characteristic of these actions is: they no longer seek to embed themselves within the established division of labor in existing global value chains; rather, they attempt to redefine the rules of value distribution. This is the essential meaning of digitalization as a "strategic asset" rather than merely an "efficiency tool."

6. Further Discussion: A Three-Dimensional Framework and Implementation Pathways for Digital Supply Chain Optimization

Based on the preceding analysis, this paper proposes a three-dimensional framework for digital supply chain optimization in Zhanjiangs aquatic product industry (Figure 2), encompassing the Industrial Ecosystem Level, Enterprise Capability Level, and Institutional Environment Level, which constitute a mutually supportive co-evolutionary system.

First Dimension: Industrial Ecosystem Level—From Platform Construction to Standard Definition

While the China Oyster Capital platform has preliminarily achieved the digital aggregation of industrial resources, the next critical leap is upgrading from a "resource pool" to a "standard pool." This involves three progressive objectives: first, unified data standards, achieving interoperability and interconnectivity of data interfaces among different farming entities, processing enterprises, and logistics service providers; second, standardized quality grading, transforming latent quality characteristics such as oyster plumpness, size, and purification level into quantifiable, verifiable grading standards; third, financialization of industrial indices, promoting the Oyster Industry Index as a reference benchmark for bank credit, insurance pricing, and futures contracts. Only by completing the transition from data aggregation to standard definition can Zhanjiang aquatic products genuinely transition from price takers to price makers.

Second Dimension: Enterprise Capability Level—From Technology Adoption to Organizational Adaptation

The value realization of digital supply chains is highly dependent on the adaptation of organizational capabilities at the enterprise level. Currently, some aquatic enterprises still equate digital transformation with purchasing software systems or establishing e-commerce storefronts, neglecting the imperatives of business process reengineering and employee digital literacy enhancement. Subsequent efforts must focus on breaking through three bottlenecks: first, cost-sharing mechanisms for SME digital adoption, exploring platform-coordinated, subscription-based SaaS service models; second, role transformation pathways for traditional traders, guiding their transition from "earning information arbitrage spreads" to "providing supply chain value-added services"; third, cross-border data compliance capacity building, cultivating enterprise capabilities in data compliance review in response to increasingly stringent RCEP member state regulations on cross-border data flows.

Third Dimension: Institutional Environment Level—From Policy Supply to Governance Coordination

Zhanjiang Customs "Twenty Measures" demonstrate proactive efforts on the institutional supply side, yet optimization opportunities remain. First, cross-departmental data sharing barriers persist, with enterprise-related data held by Customs, market regulation, agriculture and rural affairs, commerce, and other departments remaining fragmented in "stovepipe" isolation, constraining the effectiveness of smart supervision models like "integrated port-zone" supervision. Second, the digital economy statistical accounting system lags, as authentic transaction data aggregated by platforms has not been effectively incorporated into local GDP 核算 or industry statistical systems. Third, Zhanjiangs discourse power in cross-border data flow rule-making is weak;

channels for transmitting local industrial demands upward during negotiations of high-standard digital trade rules such as CPTPP and DEPA remain obstructed. It is recommended that Zhanjiang, leveraging its strategic location as a maritime cooperation node city under the Belt and Road Initiative, take the lead in exploring pioneering pilot policies for cross-border trade data flows specific to aquatic products.

7. Conclusions and Implications

This study, set against the institutional backdrop of the Sino-US trade tariff war and grounded in the empirical field of digital supply chain optimization for Zhanjiang aquatic products, systematically investigates the process, mechanisms, and theoretical implications of external trade shocks forcing the transformation of traditional industrial supply chains. The main conclusions are threefold:

First, the impact of the tariff war is not uniformly distributed across all segments of the industrial chain but is transmitted differentially according to the degree of export orientation. Aquatic species with higher proportions of exports to the US face significant price pressure, with profit margins in the farming segment severely compressed. This pressure enters enterprise decision-making horizons through three pathways—order contraction, price transmission, and expectation perturbation—serving as a key driving force forcing digital transformation of the supply chain.

Second, the digital optimization of Zhanjiang's aquatic product supply chain manifests in three parallel and interlocking pathways: smart supervision empowerment on the institutional supply side by Customs, construction of an industrial internet platform led by local state-owned enterprises, and the creation of a cross-border cold chain digital hub initiated by a leading enterprise. These three pathways correspond to the institutional environment, industrial midstream, and infrastructure levels respectively, collectively forming the prototype of a regional aquatic industry digital ecosystem.

Third, the core mechanism through which digital supply chain optimization counteracts tariff shocks is not localized efficiency improvement, but rather a systemic restructuring of the supply chains value distribution capability. Market diversification deconstructs singular tariff risk; transparent price formation reshapes trade gain distribution; full-chain traceability builds capacity to counter non-tariff barriers—these three mechanisms collectively point toward a paradigm shift from "passively bearing tariffs" to "actively defining value."

The theoretical contribution of this study lies in integrating the hitherto separate research streams of tariff transmission effect analysis and supply chain digitalization studies, proposing the "Institutional Pressure—Supply Chain Response—Value Reconstruction" analytical framework. This reveals the digital mediating mechanisms through which trade policy shocks transmit to industrial micro-practices. This framework is not only applicable to explaining the Zhanjiang case but also provides a transferable analytical tool for understanding digital transformation in other export-oriented agricultural production areas.

This study also has several limitations. First, due to data availability constraints, it was unable to quantitatively measure the costs and benefits of digital supply chain

optimization; subsequent research could leverage enterprise-level data from Quanlian Jicai or the China Oyster Capital platform to conduct quasi-experimental studies. Second, the study period is concentrated during the ongoing tariff war from 2018 to 2025, precluding examination of the dynamic evolutionary trajectory of digital transformation over a longer timeframe. Finally, the study focuses solely on Zhanjiang; the absence of cross-regional comparative research limits the external validity of its findings. It is hoped that subsequent research, building on richer empirical evidence, will continue to deepen theoretical understanding of traditional industry digital transformation amidst trade friction.

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