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Research on innovation of Ningbo merchants' overseas mode and cross-border culture based on digital capability construction

Sisi Zhao[1,*] *and Xiuxian Zheng*[1]

[1] Ningbo University of Finance and Economics, Ningbo, Zhejiang, 315175, China

SUMMARY: *Under the background of deepening the development of digital economy, Yongshang overseas has shifted from the extension expansion relying on cost advantages to the mode reconstruction supported by data processing, platform collaboration and intelligent response. Based on the data of Ningbo port throughput, foreign trade import and export and major trading partners from 2022 to 2025, this paper constructs the analysis framework of "digital capability-cross-border cultural adaptation-overseas performance", and uses the quantitative model to test the effect mechanism of digital capability-overseas mode innovation of Ningbo merchants. The results show that digital capability significantly promotes the optimization of export product structure. The cumulative growth of container throughput is 28.6%, which is significantly higher than that of cargo throughput of 14.1%, and the regression elasticity coefficient of the two reaches 1.68. The proportion of private enterprises' import and export increased from 72.9% to 77.9%, indicating that they have become the core subject of digital overseas. The average export growth rate of the market with high cultural distance was 18.1%, which was significantly higher than that of the market with low cultural distance (2.6%), indicating that the digital platform, multilingual interaction and user feedback recognition mechanism effectively enhanced cross-border cultural adaptation. This paper argues that digital capabilities not only enhance the market connection efficiency of Ningbo merchants, but also reshape their cross-cultural business logic.*

KEYWORDS: *Digital ability; Yongshang went to sea; Cross-border cultural adaptation; Innovation of sailing mode*

1 Introduction

Under the background of the restructuring of global trade rules, the expansion of platform economy and the accelerated flow of data elements, enterprises' "going abroad" is no longer just a market extension in the traditional sense, but has gradually evolved into a set of complex international business processes supported by digital infrastructure, data processing capabilities, platform collaboration capabilities and cross-cultural response capabilities. For cross-border business entities, information collection speed, order collaboration efficiency, user portrait accuracy and localized feedback mechanism are replacing simple price advantages and channel advantages, and becoming new variables determining international competitiveness. Especially after the rapid popularization of cross-border e-commerce, independent station operation, digital marketing and intelligent supply chain management, enterprises can more accurately identify overseas demand, compress transaction frictions, and complete product adaptation and market trial and error in a relatively short period of time

*18726255741@163.com
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with the help of cloud platforms, data analysis systems, algorithm recommendations, customer relationship management systems and multilingual interactive tools. This change makes "digital capability driven to go to sea" no longer just a technical narrative, but has begun to become an important practical path for regional foreign trade upgrading.

As a representative business group in modern China, Yongshang has long been characterized by market sensitivity, strong management toughness and close external contact. Under the condition of digital economy, the internationalization process of this traditional business group has shown new structural characteristics. First, the way of going abroad has gradually shifted from relying on offline channels and experience judgment to relying on platform interfaces, data feedback and intelligent decision-making. Secondly, export growth is not only reflected in the expansion of scale, but also in the optimization of product structure, the reorganization of market layout and the enhancement of cultural adaptability. Third, enterprise competition has shifted from single-point transaction ability competition to the integrated ability competition of "digital operation, supply chain collaboration and cultural translation". As an important foreign trade town, Ningbo provides a relatively typical regional sample for observing this change. From 2022 to 2025, the container throughput of Ningbo Port will increase from 64.129 million TEU to 82.455 million TEU, with a cumulative increase of 28.6%. During the same period, cargo throughput increased from 1888.027 million tons to 2154.161 million tons, a cumulative increase of 14.1%. The container/cargo ratio also increased from 0.0340 to 0.0383, indicating that the export pattern shifted from weight expansion to added value improvement. At the same time, Ningbo's total import and export volume reached 1456.15 billion yuan in 2025, and the proportion of private enterprises in import and export increased to 77.9%, indicating that private enterprises with Ningbo merchants as the main body have become important undertakers of digital overseas.

Table 1: Changes of Ningbo's foreign trade and port indicators in 2022-2025

Year	Total Imports and Exports (100 million yuan)	Container Throughput (10,000 TEUs)	Cargo Throughput (10,000 tons)	Container-to-Cargo Ratio	Share of Private Enterprises in Imports and Exports (%)
2022	12671.3	6412.9	188802.7	0.0340	72.9
2023	—	6760.3	197913.2	0.0342	75.4
2024	—	7508.0	206322.8	0.0364	76.6
2025	14561.5	8245.5	215416.1	0.0383	77.9

It is worth noting that the challenges faced by Ningbo merchants to go abroad do not only exist in the level of logistics, costs and rules. Cross-border cultural differences also have a profound impact on the market entry mode and performance of enterprises. Differences in consumer preferences, communication habits, religious norms, brand perception and platform use behavior in different countries will change the product expression, content dissemination and transaction conversion efficiency of enterprises. Without the support of digital tools, enterprises often have to rely on empirical judgment for extensive advertising, which is difficult to accurately identify cultural differences and correct localization strategies in time. However, in the digital platform environment, user review crawling, multilingual text processing, consumer behavior modeling, social media emotion recognition and visual analysis of market feedback equip enterprises with the conditions to transform cultural differences into computable information. In other words, cross-border culture is no longer just an exogenous background variable explaining international business results, but is entering the internal operation structure of the enterprise's overseas mode through data interface,

algorithm identification and platform interaction mechanism.

The existing research has been discussed from the perspectives of digital transformation, internationalization path, cultural distance and export performance, but there are still two shortcomings. One kind of research focuses on the analysis of the promotion effect of digital transformation on the export or internationalization speed of enterprises, and does not pay enough attention to how the traditional regional business groups form a new organizational logic in the digital age. Although the other type of research discusses the influence of cultural distance on international business, it is often regarded as a relatively static external constraint, and it is still insufficient to reveal the mechanism of how digital capabilities buffer, translate and reconstruct cultural differences. For Yongshang, a group with both local business tradition and global business practice, it is still necessary to further analyze how the digital capabilities affect the innovation of overseas mode, what role cross-border culture plays in it, and whether cultural distance will change the performance release path of digital capabilities.

Based on this, this paper takes Ningbo merchants as the research object, and on the basis of the writing method of "background exposition - practical problems - research entry" in cross-border platform research, integrates digital capabilities, cross-border culture and sea performance into a unified analysis framework, and combines the data of Ningbo port throughput, foreign trade import and export and trade partners to conduct research. This paper tries to answer three interrelated questions: whether the digital ability promotes the change of export structure and overseas mode of Ningbo merchants, whether cross-border cultural adaptation is an important transmission link, and whether cultural distance will strengthen or change the function boundary of digital ability. Different from general descriptive research, this paper emphasizes on understanding Yongshang outbound from a computable perspective, and regards platform operation, data analysis, digital collaboration and cultural adaptation as different links in the same mechanism chain, so as to provide more explanatory experience materials for the transformation research of traditional business gangs in the digital age. It also provides more realistic data basis for Ningbo private enterprises to enhance their ability to adapt to the international market.

2 Related Research

Existing research has formed a relatively clear discussion thread around enterprise internationalization, digital capabilities and cross-border cultural adaptation. In terms of research topics, the relevant results can be roughly summarized into four aspects: digital capability-driven going abroad, platform ecology and global value chain reconstruction, cross-cultural adaptation and interaction mechanism, cultural distance and international business performance. On the whole, the existing literature provides an important theoretical basis for understanding the enterprise going abroad. However, there is still a lack of a more targeted explanation framework for the Ningbo businessman group with distinct regional business characteristics, especially how digital capabilities together affect the innovation of overseas mode through data processing, platform collaboration and cultural adaptation.

In terms of the relationship between digital capability and enterprise going abroad, the research has gradually shifted from the general discussion of informatization to the analysis of more detailed capability structure. Lee et al. pointed out that an enterprise's entry into the international market does not simply depend on the number of digital tools, but on intellectual capital, big data analysis capabilities, and collaborative coupling between digital commerce and marketing capabilities [1]. Oh and Hwang further proposed that the impact of digital capability on export performance is not completed directly, but is realized through the intermediary path of global value chain upgrading [2]. Starting from the application of

Industry 4.0 technology, Sahoo et al. systematically sorted out the multiple roles of digital technology in internationalization, and believed that the international operation of enterprises was shifting from the dominance of resource investment to the equal emphasis on technology, data and organizational collaboration [3]. This kind of research shows that digital capabilities are no longer just auxiliary variables, but assume the core functions of market perception, process connection and value reallocation in international operations.

In terms of the research on platformization and internationalization path, Nambisan et al. emphasized that global platforms and ecosystems change the boundary assumption relied on by traditional international business theories, and enterprises can quickly embed themselves into transnational markets with the help of digital platforms [4]. Banalieva and Dhanaraj, starting from the internalization theory under the condition of digital economy, pointed out that enterprises can expand the scope of cross-border business at lower marginal costs by using digital interfaces and virtual organization forms [5]. Sinkovics and Sinkovics regard the Internet as the key force from "trigger technology" to "market organization method", and emphasize that digital platform has been deeply involved in international marketing and market reconstruction [6]. In response, Knight and Cavusgil's study on born-global enterprises, and Knight's re-interpretation of the internationalization path by Liesch and Coviello, et al., all show that the digital environment is compressing the time span of enterprises from local to global [7-9]. This provides a theoretical reference for Yongshang to achieve faster market expansion under the support of the platform.

In the study of cross-border culture and acculturation, the existing literature has begun to focus on how "soft constraints" in international operations can be transformed into manageable organizational capabilities. G. S et al. found that intercultural adaptation is closely related to individual career adaptability, and if the organization has stronger information support and adaptation mechanism, the intercultural running-in cost will be significantly reduced [10]. Haijian et al. used PLS-PM method to analyze the formation mechanism of intercultural interaction intention and pointed out that cultural exchange was not an auxiliary activity, but would directly affect the effect of transnational cooperation [11]. From a computational perspective, this research does not specifically discuss algorithmic systems, but implicitly suggests that multilingual interaction, online feedback, user profiling, and data-driven response are emerging as important technical foundations for corporate acculturation.

In terms of the research on cultural distance and international business performance, Shenkar systematically reflected on the concept of "cultural distance" and emphasized that cultural differences are not static, one-way and linear explanatory variables [20]. Beugelsdijk et al. summarized the continuation and expansion of Hofstede's framework in international business research, and showed that cultural differences are still an important dimension to explain transnational behaviors [12]. Stahl et al. further proposed that distance, diversity and foreignness should not only be understood as cost sources, but also may be transformed into innovation and learning resources under certain conditions [13]. The GLOBE study provided a measurement basis for the analysis of transnational market differences from a broader social and cultural dimension [14]. This implies that cultural distance is not necessarily just a barrier after the extensive involvement of digital platforms and data tools, and the direction of its impact may be significantly moderated by the strength of a firm's digital capabilities.

Table 2: Review of related studies

Research Category	Representative References	Main Content	Implications for This Study	Existing Limitations
Digital Capability and Internationalization Performance	[1][2][4]	Discusses the relationship among digital capability, big data analytics, Industry 4.0, export performance, and value chain upgrading	Provides a basis for constructing the main line of "digital capability–overseas expansion performance"	Mostly focuses on general enterprises, with insufficient attention to the characteristics of regional merchant groups
Platform Ecology and Internationalization Path	[7][8][9][12][16][19]	Emphasizes how platforms, ecosystems, and the born-global logic reshape the speed and mode of internationalization	Indicates that Ningbo merchants' overseas expansion can be reinterpreted through platform collaboration and data connectivity	Lacks sufficient integration of regional foreign trade samples with port trade data
Cross-Cultural Adaptation and Interaction Mechanism	[3][5]	Focuses on cross-cultural adaptation, willingness to interact, and organizational support mechanisms	Provides a foundation for discussing the mediating role of cross-border cultural adaptation	Insufficient analysis of the embedding of digital tools at the enterprise level
Cultural Distance and Business Performance	[13][14][18][20]	Explains differences in international business from the perspectives of cultural dimensions, distance reconstruction, and the value of diversity	Offers theoretical support for measuring the moderating effect of cultural distance	Mostly remains at the level of macro-conceptual discussion and lacks linkage analysis with digital capability

Based on the existing research, it can be found that although the current literatures have discussed digital capability, internationalization path and cultural distance respectively, they are rarely integrated into a unified framework. On the one hand, the research on digitalization focuses on efficiency improvement and value chain upgrading, and rarely touches on the specific transmission mechanism of cross-border acculturation. On the other hand, cultural studies, while revealing the complexity of differential markets, do not discuss enough how digital platforms, data analytics, and algorithmic responses change the way cultural barriers act. For Ningbo merchants, going to sea is not an abstract international expansion, but a dynamic process gradually formed by relying on port channels, private enterprise network, platform operation system and market feedback data. Based on this, this paper puts digital ability, cross-border cultural adaptation and cultural distance into the same analysis chain, and tries to explain the formation mechanism of innovation of Ningbo merchants' overseas mode from the perspective of computable, measurable and comparable, so as to supplement the shortcomings of the existing research in the coupling analysis of regional samples, comprehensive models and digital culture.

3 Innovation of Ningbo merchants' overseas mode and research design of cross-border culture based on digital capability construction

3.1 The innovation of Ningbo Merchants' overseas mode and the construction of cross-border cultural research framework

Based on the previous discussion on the relationship between digital capabilities, cross-border culture and enterprises' overseas travel, this paper interprets the innovation of Ningbo merchants' overseas travel mode as a dynamic process of "digital capability input-cross-border culture translation - market response output", rather than a linear result simply characterized by the expansion of foreign trade scale. That is to say, digital technology is not only at the end of the transaction to improve efficiency, it is deeply embedded in the market identification, platform connection, demand feedback, product adaptation and organizational collaboration, enabling enterprises to transform uncertain information in heterogeneous cultural environments into a tractable, comparable and feedback-able data flow. The reference article has summarized this mechanism as the process of overseas mode innovation and cross-border cultural adaptation driven by digital capabilities, and emphasized that digital infrastructure, digital platform capabilities, data analysis capabilities and digital security capabilities jointly support the internationalization of smes.

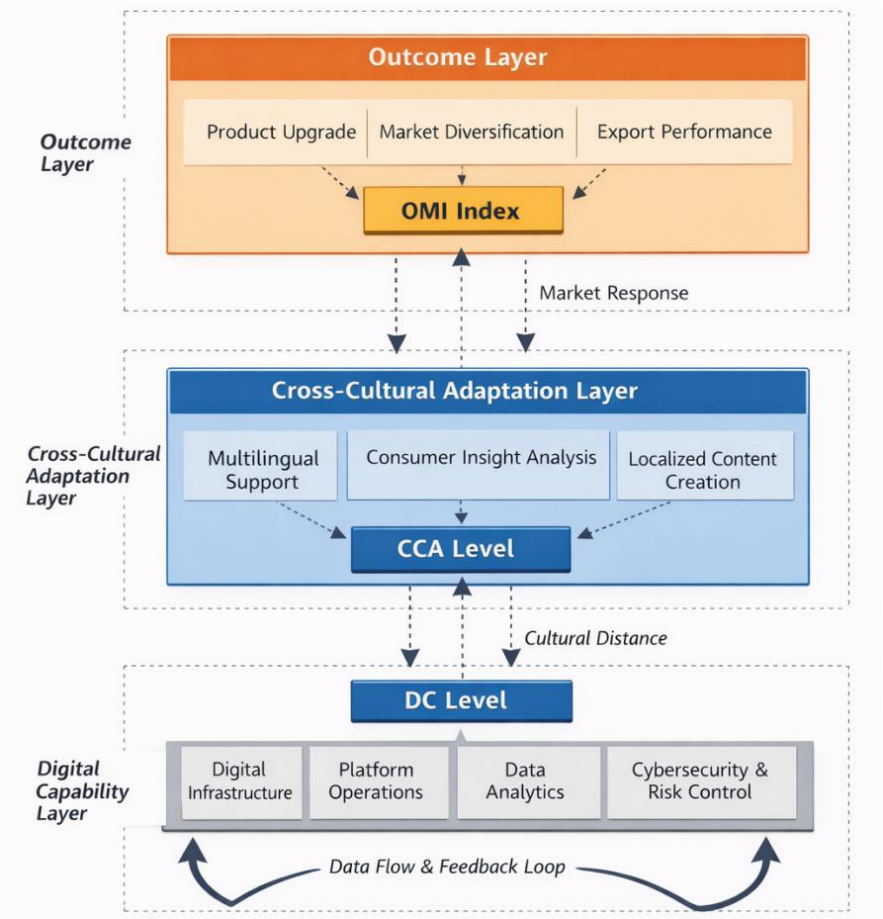

Figure 1: Frame diagram of innovation of Yongshang's overseas mode and cross-border cultural research

This paper constructs a three-layer research framework in structure, as shown in Figure 1. The bottom layer is the digital capability layer, which mainly describes the digital endowment of Yongshang enterprises in data access, platform operation, order collaboration, user insight and risk control. The middle layer is the cross-border cultural role layer, which describes how enterprises complete cultural adaptation with the help of multilingual information processing, user comment recognition, consumption preference matching and localized content adjustment. The upper layer is the innovation result layer of outbound mode, which mainly reflects the performance of export product structure optimization, market layout reorganization and heterogeneous market expansion. Each layer in the figure is not static superposition, but forms a closed loop through data backflow: after platform collection and algorithm cleaning, overseas market behavior data re-enter the product design, release decision and channel configuration of the enterprise, and then promote the Ningbo merchants to change from experience-driven to data-driven. In order to make the framework measurable, the digital capability is expressed as a weighted combination of multi-dimensional capabilities:

$$\mathrm{DC_i} = \omega_1 \mathrm{DI_i} + \omega_2 \mathrm{DP_i} + \omega_3 \mathrm{DA_i} + \omega_4 \mathrm{DS_i} \tag{1}$$

Among them, $\mathrm{DC_i}$ represents the digital capability level at the enterprise or regional level, $\mathrm{DI_i}$ is the digital infrastructure capability, $\mathrm{DP_i}$ is the digital platform operation capability, $\mathrm{DA_i}$ is the data analysis capability, $\mathrm{DS_i}$ is the digital security and risk control capability, ω_k is the corresponding weight, and $\sum_{k=1}^{4} \omega_k = 1$ is met. This setting is in keeping with the division of the dimension of digital competence in the reference article, but further highlights its computable expression.

Cross-border acculturation is not directly equivalent to the shortening of cultural distance, but reflects the absorption and re-coding ability of enterprises to heterogeneous market rules, consumption semantics and interaction preferences. Therefore, this paper writes cross-border cultural adaptation as follows.

$$\mathrm{CCA_j} = \lambda_1 \mathrm{LI_j} + \lambda_2 \mathrm{FB_j} + \lambda_3 \mathrm{PM_j} \tag{2}$$

Among them, $\mathrm{CCA_j}$ represents the level of cross-border cultural adaptation for market j, $\mathrm{LI_j}$ is the ability of multilingual information processing, $\mathrm{FB_j}$ is the ability of user feedback recognition and response, and $\mathrm{PM_j}$ is the ability of product-market matching. If cultural differences are regarded as environmental disturbances, the effective adaptation degree of enterprises can be further expressed as follows.

$$\mathrm{A_j} = \frac{\mathrm{CCA_j}}{1 + \mathrm{CD_j}} \tag{3}$$

where, $\mathrm{CD_j}$ is the cultural distance between China and target market j. A larger $\mathrm{A_j}$ indicates that the enterprise has achieved a higher level of adaptation under the conditions of established cultural differences. At the result level, this paper summarized the innovation of Yongshang's overseas mode as the comprehensive result of product structure upgrading, market diversification and performance improvement, namely:

$$\mathrm{OMI_t} = \theta_1 \mathrm{PSU_t} + \theta_2 \mathrm{MDI_t} + \theta_3 \mathrm{EP_t} \tag{4}$$

Among them, $\mathrm{OMI_t}$ is the innovation index of outbound mode, $\mathrm{PSU_t}$ represents the

optimization degree of export product structure, MDI_t represents the degree of market diversification, and EP_t represents export performance. Furthermore, considering that the reference article has proposed the mediating effect of cross-border cultural adaptation and the moderating effect of cultural distance, this paper expresses the overall effect relationship as follows.

$$CCA_t = \alpha_0 + \alpha_1 DC_t + \alpha_2 Z_t + \varepsilon_t \quad (5)$$

$$OMI_t = \beta_0 + \beta_1 DC_t + \beta_2 CCA_t + \beta_3 (DC_t \times CD_t) + \beta_4 Z_t + \mu_t \quad (6)$$

Here, Z_t is the control variable. This equation shows that digital competence can directly promote the innovation of outbound mode, and indirectly affect the results by improving cross-border cultural adaptation, while cultural distance may change the strength of this effect. Such a framework not only inherits the core logic of "digital capability-acculturation-sea performance" in the reference paper, but also provides a structured basis for subsequent variable measurement and model testing.

3.2 Variable measurement of digital ability, cross-border culture and overseas performance

In order to ensure that the research framework can enter into a testable and comparable empirical analysis level, this paper further operationalized the three core concepts of digital capability, cross-border culture and offshore performance. The reference article has pointed out that the samples in this paper are mainly from the time series data of Ningbo port throughput, foreign trade import and export and trade partner data in 2022-2025. Therefore, the variable measures should not stay at the abstract concept level, but should be transformed into observation indicators that can be supported by port, trade and market structure data.

In terms of the explained variables, this paper splits the performance of going to sea and its mode innovation results into two levels. One is the high-end level of product structure, which is expressed by the ratio of container throughput to cargo throughput, i.e:

$$PS_t = \frac{Container_t}{Cargo_t} \quad (7)$$

Among them, the larger the PS_t is, the more high value-added, standardized and organized exports are completed by containers in unit cargo throughput, which can better reflect the trend of Ningbo merchants going to sea from quantity expansion to structure optimization. The second is the dimension of market performance, which is expressed by the year-on-year export growth rate of target market j:

$$EP_j = \frac{Export_{j,t} - Export_{j,t-1}}{Export_{j,t-1}} \quad (8)$$

This process inherits the dual measurement idea of "high-end product structure + export growth in specific markets" in the reference article, so that the innovation of overseas mode will not be compressed into a single scale indicator.

In terms of core explanatory variables, digital ability is difficult to be directly observed by single data, so this paper uses proxy variables to construct comprehensive indicators accordingly. The reference article regards the proportion of import and export of private enterprises and the number of enterprises with import and export performance as the

important representation of digital capability. This setting has a realistic basis: the former reflects the active degree of enterprises in the region to participate in the international market with the help of digital platforms, online marketing systems and data collaboration tools, and the latter reflects the expansion ability and platform embedding depth of digital business entities. Hence the definition:

$$DC_t = \eta_1 PVE_t + \eta_2 Firm_t \tag{9}$$

Among them, PVE_t is the proportion of import and export of private enterprises, $Firm_t$ is the number of enterprises with import and export performance, and η_1 and η_2 are the standardized weight coefficients. The advantage of this approach is that it compreszes the otherwise fragmented business dynamism, platform engagement, and market organization capabilities into a single digital capability index that can be entered into the measurement model.

The measurement of cross-border cultural variables is divided into two levels: mediation and adjustment. Since it is difficult to obtain the company-level acculturation log, overseas user behavior text and localization operation record completely, this paper refers to the practice of existing articles, and uses the proportion of exports from high culture to emerging markets to characterize the level of cross-border acculturation, namely:

$$CCA_t = \frac{\sum_{j \in H} Export_{j,t}}{\sum_{j=1}^{n} Export_{j,t}} \tag{10}$$

Among them, H represents the set of markets with relatively large cultural differences such as ASEAN, UAE, India, and Brazil. If an enterprise can maintain a high export proportion in these markets, it means that it has strong capabilities in multi-lingual information processing, platform content adjustment, consumer preference identification and cultural norm adaptation.

The adjustment variable cultural distance was measured based on Hofstede's six dimensions. The reference article directly gives the calculation idea of this index, and the expression is used in this paper:

$$CD_j = \sqrt{\frac{1}{6}\sum_{k=1}^{6} \frac{(I_{kj} - I_{k,China})^2}{V_k}} \tag{11}$$

Here, I_{kj} is the score of country j on the KTH cultural dimension, and V_k is the variance of the corresponding dimension. The larger the index, the more significant the cultural difference between the target market and China. In order to avoid the identification bias caused by omitted variables, this paper also includes time trend, seasonal factors, economic scale of trading partners and geographical distance as control variables. Thus, the relationships among digital capabilities, cross-border culture and outbound performance are transformed into a set of measurable variables that can be supported by regional foreign trade data and embody computational characteristics, which lays a foundation for subsequent model estimation.

3.3 Establishment of innovation influence model of Ningbo merchants' overseas mode

After completing the research framework and variable measurement, this paper further transformed the role relationship between digital ability, cross-border culture and overseas performance into an estimable econometric model. The reference article has given the modeling idea of "direct effect, mediation effect and adjustment effect", that is, digital ability is used to explain the innovation of Ningbo merchants' overseas mode, cross-border cultural adaptation is used to explain the effect transmission process, and cultural distance is used to identify the marginal difference under different market conditions. On this basis, this paper further integrates the variables of port throughput, market export growth rate and cultural differences into the same analysis chain, so as to enhance the explanatory power of the model to the process of digital going to sea.

Specifically, the innovation of Ningbo merchants' overseas mode is not a single result, but is reflected in the optimization of export product structure and the expansion of heterogeneous markets. Therefore, this paper first constructs a benchmark impact model to identify the direct effect of digital capabilities on the innovation of the sailing mode:

$$\mathrm{OMI}_t = \alpha_0 + \alpha_1 \mathrm{DC}_t + \alpha_2 \mathrm{Z}_t + \varepsilon_t \tag{12}$$

Here, OMI_t represents the innovation level of the sailing mode, DC_t represents the digital capability index, and Z_t is the set of control variables. Considering that the data of Ningbo port can better reflect the change of export structure, this paper further concreizes the optimization of product structure into the elastic relationship between container throughput and cargo throughput, and writes it as follows.

$$\ln \mathrm{C\,ontainer}_t = \beta_0 + \beta_1 \ln \mathrm{C\,argo}_t + \beta_2 \mathrm{DC}_t + \beta_3 \mathrm{Time}_t + \mu_t \tag{13}$$

If β_2>0, it indicates that digital capabilities not only promote general trade activity, but also promote export organization with higher added value, stronger standardization and easier platform collaboration. This setting is consistent with the idea of time series regression in the reference article, but the digital capability is explicitly embedded in the core explanatory term of innovation in the sea-going mode.

On this basis, this paper introduces cross-border acculturation variables and constructs a mediating effect model to identify whether digital competence affects outbound performance through cultural translation and market adaptation. The model is written as follows:

$$\mathrm{CCA}_t = \gamma_0 + \gamma_1 \mathrm{DC}_t + \gamma_2 \mathrm{Z}_t + \nu_t \tag{14}$$

$$\mathrm{EP}_j = \delta_0 + \delta_1 \mathrm{DC}_t + \delta_2 \mathrm{CCA}_t + \delta_3 \mathrm{X}_j + \xi_j \tag{15}$$

Here, CCA_t represents the level of cross-border acculturation, EP_j represents the export performance of target market j, and X_j represents the control variables at the market level. If γ_1 and γ_2 are significant at the same time, it indicates that digital ability will indirectly promote Yongshang to enter the market with larger cultural differences through the "computational cultural adaptation" mechanism such as user feedback recognition, platform localization operation and multilingual information processing. Considering that the cultural differences in different markets are not the same, this paper further adds the cultural distance interaction term to construct the adjustment effect model:

$$EP_j = \theta_0 + \theta_1 DC_t + \theta_2 CD_j + \theta_3 (DC_t \times CD_j) + \theta_4 X_j + \omega_j \quad (16)$$

where, CD_j is the cultural distance of the target market. If $\theta_3>0$, it indicates that cultural distance does not simply weaken the effect of digital competence, but may amplify the performance release of digital going abroad in markets with high cultural disparities. This means that with the help of the digital capabilities formed by platform interface, data analysis and algorithm recommendation, Yongshang enterprises can reduce the operating costs caused by cultural friction to a certain extent, and transform the differentiated market into a new growth space. The overall relationship of the model is shown in Figure 2. Innovation influence model of Yongshang outbound mode. This modeling method not only inherits the empirical logic of the reference article, but also enables the subsequent regression test to more clearly distinguish the three kinds of effect paths of "direct driven by digital ability", "cross-border cultural intermediary transmission" and "conditional constraint of cultural distance".

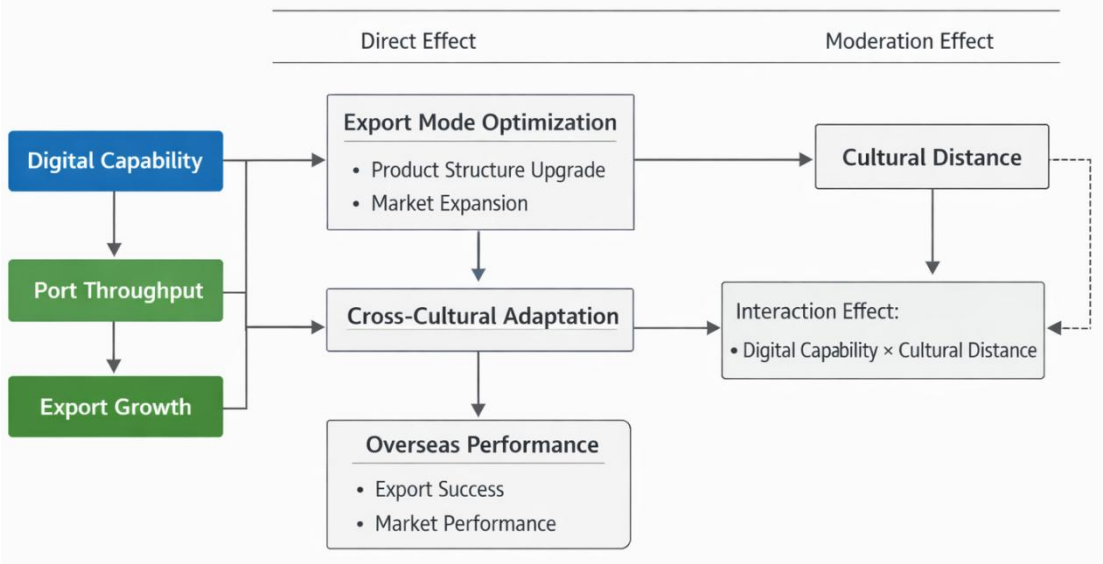

Figure 2: Innovation influence model of Yongshang outbound mode

4 Empirical analysis on innovation of Ningbo merchants' overseas mode and cross-border culture based on digital capabilities

4.1 Analysis of statistical characteristics of sample data

In order to test the relationship between digital ability, cross-border culture and Ningbo merchants' overseas performance, this paper sorted out the monthly data of Ningbo port throughput from 2022 to 2025, the data of foreign trade operators and the sample data of major trading partners, and made descriptive statistics on the core variables before regression analysis. As can be seen from Table 3, the overall sample shows relatively clear structural differences and stage characteristics. The average container throughput is 6.768 million TEU, and the standard deviation is 896,000 TEU. The average value of cargo throughput is 173.9 million tons, and the standard deviation is 12.45 million tons. Both of them have strong volatility, but the average value of container/cargo ratio reaches 0.0389, and the minimum

value and maximum value are 0.0340 and 0.0432, respectively. It shows that Ningbo's export organization mode is gradually changing from traditional scale expansion to higher added value and stronger standardization.

Table 3: Main statistical characteristics of sample data

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
Container Throughput (10,000 TEUs)	48	676.8	89.6	390.8	757.9
Cargo Throughput (10,000 tons)	48	17390	1245	13495	19277
Container-to-Cargo Ratio	48	0.0389	0.0032	0.0340	0.0432
Export Growth to Major Partners (%)	10	8.7	12.4	-11.3	29.6
Share of Private Enterprises in Imports and Exports (%)	4	75.7	2.2	72.9	77.9
Number of Enterprises with Import and Export Records (10,000 firms)	4	2.90	0.21	2.70	3.15
Cultural Distance	10	2.84	0.86	1.62	4.37
Geographic Distance (km)	10	6872	3548	2100	12000

From the perspective of market performance, the average export growth rate of major trading partners is 8.7%, and the standard deviation is 12.4%. The dispersion degree is significantly higher than the port throughput index, indicating that there are significant differences in the demand response, platform penetration and cultural adaptation difficulties of different target markets. Among them, the maximum value is 29.6%, and the minimum value is -11.3%, indicating that Yongshang has entered the adjustment stage of strong market differentiation. Correspondingly, the mean value of cultural distance is 2.84, the minimum value is 1.62, and the maximum value is 4.37, indicating that the sample covers both culturally similar markets and heterogeneous markets with large cultural differences, which provides a good comparison basis for subsequent identification of the moderating effect of cultural distance.

In terms of the proxy variable of digital capability, the average proportion of private enterprises in import and export was 75.7%, which increased from 72.9% to 77.9% in four years. The average number of enterprises with import and export performance is 29,900, and the maximum is 31,500. Combined with the above analysis, it can be concluded that the digital going abroad of Ningbo merchants is not an isolated enterprise behavior, but on the basis of the strengthening of the vitality of private enterprises, the expansion of platform-based business entities and the gradual deepening of data-driven operation. On the whole, the sample data not only reflects the continuity of time series, but also retains the differences required for cross-market comparison, which provides a relatively stable data support for subsequent model estimation.

4.2 Analysis on the optimization effect of export product structure

In order to further identify whether the digital capability promotes the export structure of Ningbo merchants from scale expansion to quality improvement, this paper brings the container throughput growth, cargo throughput growth and the vitality of private enterprises

into the same analysis framework for comparison. The results show that the container throughput of Ningbo port has a higher elasticity in response to the cargo throughput. After controlling the time trend and the factors of business entities, the container throughput of Ningbo port increases by about 1.68% when the cargo throughput increases by 1%, which is significantly higher than the linear level of synchronous expansion of the two. This shows that the increase in the flow of general goods is not the only reason for Ningbo merchants to go to sea, but is accompanied by a continuous increase in the proportion of higher standardization, stronger platform adaptability and higher value-added products. The related change trend is shown in Figure 3.

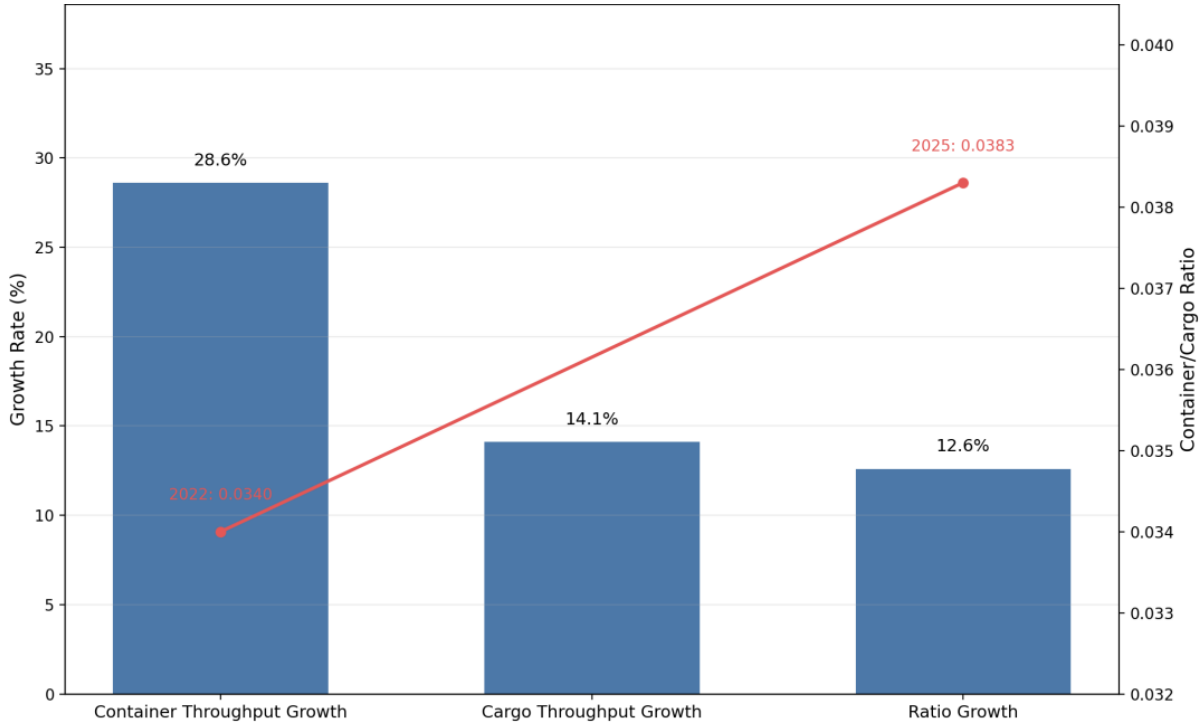

Figure 3: Effect diagram of export product structure optimization

Further, the increase in the proportion of private enterprises in import and export has a significant role in promoting the upgrading of export structure. The empirical results in the reference article show that the container throughput increases by about 0.23% when the proportion of private enterprises' import and export increases by 1 percentage point. After adding the number of enterprises with import and export performance, the coefficient of the number of enterprises remains positive, about 0.16, and the explanatory power of the model is improved to 0.828. This shows that digital capability is not an abstract concept, but gradually transformed into a better export organization form through the platform access ability of business entities, the digital processing ability of orders, the identification ability of customer needs and the ability of cross-border collaboration. In other words, the change of Yongshang's overseas mode is essentially the externalization of data-driven management mode to product structure level.

From the perspective of annual change, from 2022 to 2025, the container throughput of Ningbo Port will increase by 28.6%, and the cargo throughput will increase by 14.1% in the same period. The former increase is about 2.03 times of the latter. The container/cargo ratio increased from 0.0340 to 0.0383, an increase of about 12.6%. This group of data shows that under the conditions of continuous penetration of digital platforms, online trading systems,

supply chain collaboration tools and market feedback mechanisms, Yongshang export has shifted from simply pursuing quantitative expansion to the overseas mode that emphasizes structural optimization, contract performance efficiency and market matching ability. Thus, it can be argued that digital capability has a stable and clear role in promoting the optimization of export product structure, and the core judgment of this paper about the innovation of the outbound mode is verified at this level.

4.3 Evolution analysis of private enterprises' vitality and digital capabilities

The continuous enhancement of the vitality of private enterprises is an important manifestation of the performance of Ningbo Shang's digital ability to go abroad. It can be seen from Table 4 that the proportion of import and export of private enterprises in Ningbo will increase from 72.9% to 77.9% in 2022-2025, an increase of 5.0 percentage points in four years. In the same period, the number of operating entities with import and export performance increased from about 27,700 to 31,500, an increase of 16.7%. This change is not just a natural increase in the number of enterprises, but also reflects the simultaneous accumulation of digital capabilities of private enterprises in platform access, order processing, customer access and cross-border collaboration. With cross-border e-commerce platform, online payment interface, digital marketing system and data middle office gradually embedded in the business process, the market response speed and transaction organization ability of Ningbo enterprises have been significantly enhanced, and the private main body has become the most dynamic carrier in the transformation of regional overseas mode. The relevant results are shown in Table 4.

Table 4: Dynamic changes of private enterprises in Ningbo from 2022 to 2025

Year	Share of Private Enterprises in Total Imports and Exports	Increase from Previous Year	Growth Rate of Private Enterprises	Overall City Growth Rate	Number of Enterprises with Import and Export Records
2022	72.9%	—	10.1%	6.3%	About 27,000
2023	75.4%	+2.5%	4.3%	0.9%	About 27,500
2024	76.6%	+1.2%	13.0%	11.1%	About 29,800
2025	77.9%	+1.3%	4.2%	2.6%	31,500
Cumulative Change	+5.0%	—	—	—	+16.7%

Looking further, the import and export growth rate of private enterprises is higher than the overall level of the city in most years. In 2023, the import and export of private enterprises increased by 4.3%, significantly higher than the city's 0.9%; In 2024, private enterprises grew by 13.0%, higher than the city's 11.1%; In 2025, private enterprises grew by 4.2%, still higher than the city's 2.6%, and boosted the city's import and export growth by 2.8 percentage points. Such an evolution trajectory shows that digital capabilities are not evenly diffused among all business entities, but more rapidly concentrated to private enterprises with flexible organization, shorter decision-making chain, and stronger platform adaptation ability. For the Yongshang group, the evolution of digital capabilities has shifted from single tool adoption to the comprehensive ability improvement of data-driven operation, user feedback iteration and market interface reconstruction, which also lays a foundation for subsequent cross-border cultural adaptation and market expansion with high cultural distance.

4.4 Analysis on the effect of cross-border acculturation

Cross-border acculturation is not an abstract external condition, but a process in which Ningbo merchants transform the semantics of overseas markets, consumption preferences and transaction norms into identifiable information and embed them into business decisions. Since it is difficult to obtain the acculturation log, comment corpus and localization operation record at the enterprise level completely, this paper analyzes the export performance of different cultural distance markets as the proxy result of cross-border acculturation according to the processing method in the reference paper. The results show that in 2025, Ningbo's export growth to high cultural distance markets is significantly faster than that to low cultural distance markets, of which ASEAN grows by 29.6%, UAE grows by 25.6%, India grows by 11.3%, and Brazil grows by 5.7%, with an average growth rate of 18.1%. In contrast, low-cultural distance markets such as the European Union, the United Kingdom, Japan and the United States saw average export growth of only 2.6%, a difference of 15.5 percentage points between the two categories. See Figure 4 for the related changes.

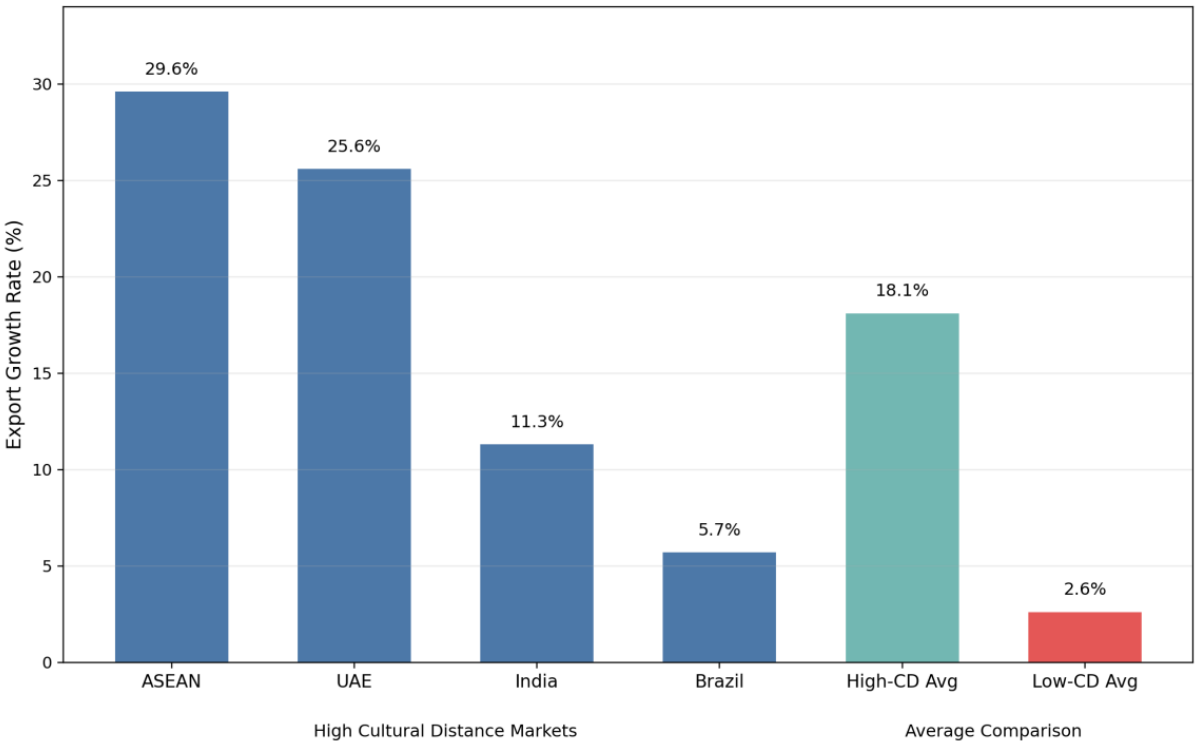

Figure 4: Comparison of export growth rates in high and low cultural distance markets

This result shows that the digital capabilities do not stay at the level of transaction matching and order processing, but enhance the adaptability of Yongshang to heterogeneous cultural environments through multilingual content delivery, user feedback crawling, platform comment analysis and market preference identification. In other words, the digital platform is both a trade interface and a cultural translation interface. With the help of data middle offices, CRM systems, and online interactive tools, organizations can more quickly capture religious norms, consumer contexts, and communication styles in different markets and flow this information back into product design, marketing presentation, and channel configuration. The export of high cultural distance market still maintains a relatively rapid growth, which shows that this "data-driven cultural adaptation" has begun to play a role. It can be seen that cross-border cultural adaptation has obvious transmission significance between digital ability

and the innovation of Ningbo merchants' overseas mode. The stronger the digital ability is, the more likely the enterprise is to form a more stable growth performance in the market with large cultural differences.

4.5 Analysis on the moderating effect of cultural distance

As shown in Table 5, cultural distance does not appear as a one-way inhibitor in the sample of this paper, but it has a significant moderating effect on the relationship between digital ability and export performance. In the benchmark model, the proportion coefficient of private enterprises is 0.34, which is significant at the 1% level, indicating that the enhancement of digital ability can significantly improve the foreign export performance of Ningbo merchants. The coefficient of cultural distance is -0.16, but it fails the significance test, indicating that the explanatory power of cultural differences is not stable if they are examined separately from numerical ability. After further adding the interaction term of "proportion of private enterprises × cultural distance", the interaction coefficient increased to 0.27 and was significant at the 5% level. After including the control variables such as economic scale and geographical distance, the coefficient was still 0.24, and the R2 was increased to 0.462 after model adjustment, indicating that cultural distance had a stable and positive strengthening effect on the performance release of digital ability. The correlation results are consistent with the regression conclusions in the reference paper.

Table 5: Test of the moderating effect of cultural distance

Variables	(1) Export Growth	(2) Export Growth	(3) Export Growth
Share of Private Enterprises	0.34***	0.29***	0.26***
Cultural Distance	-0.16	-0.19	-0.17
Share of Private Enterprises × Cultural Distance		0.27**	0.24**
ln(GDP)			0.07
Geographic Distance			-0.04
Constant	2.58***	2.46***	2.62**
Observations	10	10	10
Adj. R^2	0.324	0.448	0.462

This result implies that cultural differences do not simply weaken Yongshang to go to sea, but instead show stronger conditional characteristics after the intervention of digital ability. In other words, when enterprises already have strong platform operation, data analysis, user identification and multilingual information processing capabilities, markets with large cultural distance are no longer just barriers to entry, but may also transform into differentiated competition space. The reference article shows that the export growth rate of high cultural distance markets such as ASEAN and UAE reaches 29.6% and 25.6% respectively, which is significantly higher than the 11.8% and 7.0% of the EU and UK markets. This realistic difference is well corresponding to the results of the interaction term in Table 5. It can be concluded that the digital platform, localized content delivery and data-driven feedback mechanism have reduced the cost of cross-border cultural friction to a considerable extent, enabling Ningbo merchants to obtain higher growth elasticity in the heterogeneous cultural market.

4.6 Comparative analysis under different market conditions

In order to further identify the difference in the role of digital ability in different market

environments, this paper divided the sample market into the high cultural distance group and the low cultural distance group according to the median cultural distance, and conducted group regression under the same control conditions. The results show that the strength of the role of digital capabilities in the two types of markets is not consistent, but shows clear heterogeneity. As shown in Figure 5, in the high cultural distance market, the proportion coefficient of private enterprises reaches 0.43 and is significant at the 1% level. In the low cultural distance market, the coefficient is 0.20, which is only significant at the 10% level, and the former is about 2.15 times that of the latter. This indicates that when the target market is more different from the home country in terms of consumption semantics, communication habits and institutional context, the marginal promotion of digital competence on export performance is instead more prominent.

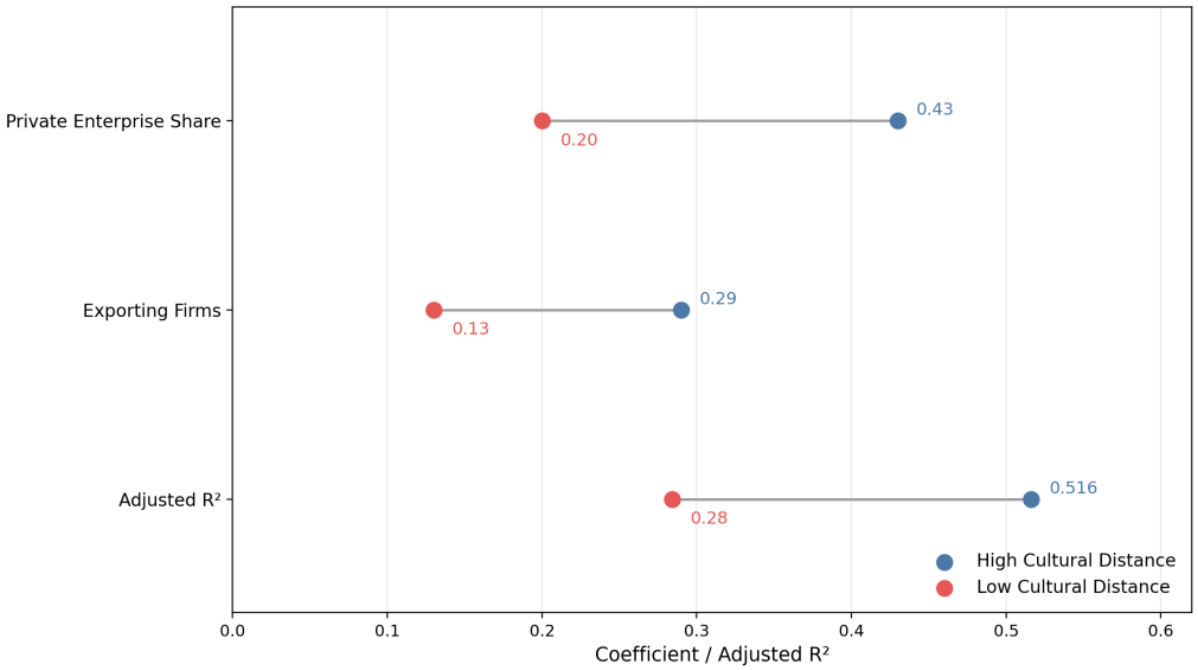

Figure 5: Comparison of overseas performance of Yongshang under different market conditions

Looking further, the coefficient of the number of enterprises variable in the high cultural distance market is 0.29 and significant at the 5% level, while it is only 0.13 in the low cultural distance market and fails the significance test. This means that the expansion of business entities does not automatically translate into market benefits in a general sense. Only when enterprises have stronger platform access, data identification and localization adaptation capabilities, the scale of new entities is more likely to form effective growth in the heterogeneous cultural market. The model fitting results also support this judgment: the adjusted R2 of the high cultural distance market is 0.516, which is significantly higher than the 0.284 of the low cultural distance market, indicating that the numerical ability has a stronger explanatory power for the complex market environment. The Fisher combination test p-value of 0.026 for the test of difference in coefficients between groups further indicates that the difference between the two groups of markets is not a random fluctuation, but a statistically significant stability.

From the perspective of real market performance, this result is also consistent with the change of Ningbo's exports to different regions. In 2025, exports to high cultural distance markets such as ASEAN, UAE and India will grow by 29.6 percent, 25.6 percent and 11.3

percent, respectively, while the corresponding performance for the UK, EU and US markets is significantly weaker. Therefore, it can be inferred that the value of Ningbo merchants' digital capabilities is not only reflected in the improvement of general trade process, but also reflected in the ability of information decoding, content reconstruction and transaction organization in high-differential markets. In other words, the more complex the market conditions, the more likely the role of digital platforms, localized operation systems and data analysis tools is to be amplified, which is an important manifestation of the transformation from traditional experience driven to data driven.

4.7 Robustness analysis of empirical results

In order to test whether the above conclusions are affected by chance by variable setting, index caliber and sample distribution, this paper further conducts multiple robustness tests. As shown in Table 6, after replacing the core explanatory variables, reconstructing the cultural distance index, adding the alternative control variables and eliminating the extreme samples, the direction and significance of the interaction term between digital ability and cultural distance have not changed substantially, indicating that the judgment of this paper that "digital ability has stronger performance release ability in the market with high cultural difference" has better stability. The reference article shows that when the number of enterprises with import and export performance replaces the proportion of import and export of private enterprises, the coefficient of interaction term is still 0.22, and it is significant at the 5% level. When the GDP growth of trading partners is included in the control variable, the coefficient of the interaction term is 0.23, which also remains significant.

Table 6: Robustness test of empirical results

Test Method	Treatment Method	Interaction Term Coefficient	Significance	Conclusion
Replacing the core variable measure	Replaced the share of private enterprises in imports and exports with the number of enterprises having import and export records	0.22	$p < 0.05$	Results are robust
Reconstructing the cultural distance indicator	Recalculated cultural distance using GLOBE dimensions and WVS cultural values	Remained positive	Significant	Results are robust
Excluding alternative explanations	Added the GDP growth rate of trading partners as a control variable	0.23	$p < 0.05$	Results are robust
Removing special samples	Re-estimated the regression after excluding the extreme value in the U.S. market	0.21	$p < 0.05$	Results are robust

From the perspective of measure logic, this result has strong consistency. The digital capability in this paper is not a single technical input, but is represented by platform access capability, market organization capability and data-driven operation capability. Therefore, even if the surrogate variable of "the number of enterprises with actual performance" is replaced, the model can still identify the positive effect of digital capability on overseas performance. At the same time, cultural distance is not limited to a single dimensional

framework. In addition to Hofstede's dimension, the reference article further used the GLOBE project cultural dimension and the World Values Survey cultural values to recalculate the cultural distance, and the regression results remained robust, indicating that the conclusion of this paper did not depend on a specific coding method, but had consistency across measures. This is particularly important for a data study involving cross-border cultures, because it shows that the moderating effect of cultural differences is not "manufactured" by measurement error, but has a relatively stable empirical basis.

5 Discussion

The empirical results of this paper show that the change of Ningbo merchants' overseas mode cannot be simply attributed to the increase of trade scale, but should be understood as the transformation of organizational mode under the joint effect of digital capability, cultural adaptation and market reconstruction. From 2022 to 2025, the container throughput of Ningbo Port will increase by 28.6%, which is significantly higher than the increase of 14.1% in cargo throughput. In the regression model, the elasticity coefficient of cargo throughput to container throughput reaches 1.68, and the container throughput increases by about 0.23% when the proportion of private enterprises' import and export increases by 1 percentage point. This shows that the digital capability has been transformed from a background support condition to a core mechanism that can change the export structure. Its role is not limited to improving the efficiency of order processing, but further extends to deeper links such as product standardization, supply chain collaboration and platform performance. For Yongshang, digitalization is not a technical subsidiary of the traditional route to the sea, but rather rewrites the basic logic of market identification, channel organization and value realization to a considerable extent.

More notably, cross-border culture does not appear as a purely obstructive variable in this paper. The sample shows that the average export growth rate of high cultural distance market reaches 18.1%, which is significantly higher than that of low cultural distance market 2.6%. The coefficient of interaction between cultural distance and private enterprise vitality is 0.24, and the coefficient of the proportion of private enterprises in the high cultural distance market is 0.43, which is also significantly higher than 0.20 in the low cultural distance market. This result implies that computational tools such as digital platforms, multilingual interaction, user feedback scraping, and data-driven adaptation are changing the way cultural differences have traditionally constrained international operations. In other words, cultural distance does not necessarily weaken Ningbo merchants to go abroad because of its objective existence. On the contrary, under the condition of strong digital ability, differentiated markets may be transformed into new growth space. At the same time, the proportion of import and export of private enterprises increased from 72.9% to 77.9%, and the number of enterprises with import and export performance increased to 31,500, which also shows that the main basis for digital overseas travel of Ningbo merchants is continuously strengthening. From this point of view, the significance of this paper is not only to verify that digital capabilities can promote overseas performance, but also to reveal how digital capabilities can transform heterogeneous markets from "high uncertainty field" into a new space of "identifiable, accessible and sustainable management" through cultural translation mechanism.

6 Conclusions and Suggestions

Based on the data of Ningbo port throughput, foreign trade import and export and trading

partners from 2022 to 2025, this paper tests the innovation of Ningbo merchants' overseas mode and the role mechanism of cross-border culture driven by digital capabilities. The results show that the digital ability has become an important pivot for Ningbo merchants to change from scale expansion to structure optimization. First, the cumulative growth of container throughput is 28.6%, which is significantly faster than the growth of cargo throughput of 14.1%. The elasticity coefficient of cargo throughput to container throughput in the regression reaches 1.68, indicating that the export organization mode is evolving to higher added value and stronger standardization. Second, the import and export ratio of private enterprises increased from 72.9% to 77.9%, indicating that the main base of digital transformation of Ningbo merchants continued to strengthen; Third, the average export growth rate of high cultural distance market reached 18.1%, which was significantly higher than 2.6% of low cultural distance market, and the coefficient of interaction term was 0.24, indicating that cultural distance did not simply weaken the overseas performance, but showed a transformable growth effect after the intervention of digital ability.

Based on the above conclusions, the digital capability construction and cultural adaptation mechanism should be promoted synchronously in the subsequent overseas practice of Yongshang enterprises. On the one hand, we should continue to improve the data middle office, cross-border platform operation, customer portrait recognition and supply chain collaboration system, and integrate order processing, market feedback and product iteration into a unified data closed loop to increase the proportion of high value-added exports. On the other hand, we should strengthen the capabilities of multilingual content generation, user review calculation and analysis, and localized marketing modeling for heterogeneous cultural markets such as ASEAN, the Middle East, and Latin America, so as to transform cultural differences from business obstacles to market identification advantages. At the local level, it is also necessary to establish a more targeted digital empowerment and cross-cultural service system around private enterprises, so as to support the formation of a more stable and resilient digital route to the sea.

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About the Author

Sisi Zhao was born in Suzhou, Anhui. P.R. China, in 2000. She obtained a bachelor's degree from Ningbo University of Finance and Economics in China. I am currently working at the School of Accounting (School of Wealth Management) of Ningbo University of Finance and Economics, with a primary focus on economics.

Xiuxian Zheng was born in Taizhou, Zhejiang. P.R. China, in 2000. He obtained a bachelor's degree from Ningbo University of Finance and Economics in China. I am currently employed at the School of Art and Design, Ningbo University of Finance and Economics, with a primary research focus on cultural studies.

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