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The Impact of New Quality Productive Forces on the High-Quality Development of China's Foreign Trade

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Abstract: The high-quality development of foreign trade is both an inherent need for China's economic transformation and upgrading and a vital driver for global economic recovery and sustainable development. Analyzing how new quality productive forces empower high-quality trade development and its mechanisms is significant. Drawing from the theoretical framework of new quality productive forces and the principles of high-quality foreign trade development, this study uses panel data from 30 Chinese provinces (2011–2021) to construct entropy-based indices for new quality productive forces and the high-quality development of foreign trade. A System GMM dynamic panel model is applied to examine their relationship and underlying mechanisms. The empirical results indicate that new quality productive forces significantly promote the high-quality development of foreign trade. Furthermore, their positive impact is more pronounced in eastern regions, provinces implementing the Belt and Road Initiative, and areas with lower resource endowments. Mechanism analysis further reveals that new quality productive forces enhance the high-quality development of foreign trade by optimizing factor matching, deepening industrial division, and intensifying market competition. This study contributes to the literature on the economic effects of new quality productive forces and provides theoretical insights and practical implications for promoting the high-quality development of foreign trade across regions.

Keywords: new quality productive forces; high-quality development of foreign trade; entropy method; mechanism analysis

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1. Introduction

Since China acceded to the WTO, it has deeply integrated into the global division of labor, significantly expanding its trade volume and rapidly emerging as one of the world's most important trading nations. However, the global economy is currently undergoing unprecedented transformations, with increasing instability in international markets and substantial changes in both demand and institutional environments. As a result, China's foreign trade is facing severe challenges. Structural imbalances persist in China's trade, with service trade imports and exports significantly below the global average, particularly in high-tech service trade (Chen et al., 2021) [1]. Certain core industries continue to face technological lock-in at the lower end of the value chain, resulting in significant disparities in product quality (Yan et al., 2023) [2]. Meanwhile, trade frictions remain intense, with China accounting for approximately 40% of global trade sanctions cases (Yang et al., 2022) [3]. Foreign trade is a key driver of China's economic growth. Thus, further opening-up, optimization of the trade structure, enhancement of the comprehensive competitiveness of

foreign trade, and the achievement of high-quality development of foreign trade will contribute to the smooth operation of both domestic and international economic cycles. These efforts not only bolster China's competitiveness and influence in global markets but also contribute to economic stability amid shifting global conditions. The high-quality development of China's foreign trade is an inevitable choice in response to evolving international dynamics and serves as a crucial pathway toward sustainable economic development.

In September 2023, President Xi first introduced the concept of "new quality productive forces" during an inspection tour. In January 2024, he further emphasized the need to accelerate the development of these new quality productive forces. The introduction of this concept represents a critical strategic initiative to address contemporary challenges and meet the demands of social and economic development. At present, global challenges such as deglobalization, unilateralism, and protectionism are becoming increasingly prominent. One of the main causes of the conflict is the lack of development (Ray et al., 2017) [4]. Developed countries must further enhance their growth strategies while developing countries continue to pursue their development agendas. In China, traditional production methods are increasingly unsustainable, necessitating a shift from quantity-driven to quality-driven productivity to address environmental and supply-side challenges. Current research on new quality productive forces can be broadly categorized into two main areas. The first focuses on the theoretical exploration of their fundamental connotations and development pathways (Zhou et al., 2023; Xie et al., 2025; Qiu, 2024) [5–7]. The second concerns the identification of key elements and the construction of measurement indicators for new quality productive forces (Wang et al., 2024; Han et al., 2024; Luo et al., 2024) [8–10].

The key to the high-quality development of foreign trade is improving the quality and efficiency of trade, which is consistent with the intrinsic requirements of new quality productive forces. This can be achieved by relying on scientific and technological progress, enhancing the quality of workers, and promoting management innovation, so as to create more high-quality new supplies, optimize the foreign trade structure, and forge new advantages in foreign trade. The existing research still has several gaps. Firstly, there is a dearth of in-depth exploration and empirical verification of the role that the development of new quality productive forces plays, especially concerning their economic impacts. Secondly, research focusing on the correlation between new quality productive forces and foreign trade is still in short supply. Moreover, the specific pathways through which new quality productive forces exert influence on the high-quality development of foreign trade have not been thoroughly elucidated. To bridge these gaps, this paper takes provincial-level data as the research focus, refines the existing evaluation system, constructs a dynamic panel model based on dynamic characteristics, and conducts an empirical analysis using the system Generalized Method of Moments (GMM) to examine the impact of new quality productive forces on the high-quality development of foreign trade. Furthermore, it explores the underlying mechanisms through three key pathways: factor matching, industrial division, and market competition. This study contributes to the theoretical development of new quality productive forces and provides policymakers with new insights into advancing the high-quality development of foreign trade in China.

2. Literature Review

2.1. Theoretical Connotation and Measurement of New Quality Productive Forces

New quality productive forces are a comprehensive concept encompassing technological innovation, industrial transformation, and shifts in economic development models. Unlike traditional productivity, new quality productive forces emerge as a result of breakthroughs in critical and disruptive technologies (Zhou et al., 2023) [5]. The essence of new quality productive forces lies in productivity transformation driven by a new

wave of technological revolution and the emergence of strategic emerging industries. As Xi Jinping mentioned, "Technological innovation can give rise to new industries, new models, and new driving forces, serving as a fundamental element for developing new quality productive forces" and "Integrating technological innovation resources to spearhead the development of strategic emerging and future industries is crucial for accelerating the formation of new quality productive forces". These statements reflect the intrinsic logic of "technology–industry–productivity" (Zhao et al., 2024) [11]. First, new quality productive forces are driven by technological innovation. Achieving breakthroughs in critical and disruptive technologies enables a qualitative leap in productivity, injecting strong momentum into economic development (Xie et al., 2024) [6]. Second, with high-quality development as its ultimate goal, new quality productive forces are guided by new development philosophies. This implies that beyond technological advancements, new quality productive forces emphasize enhancing the quality of productivity, transitioning from quantitative accumulation to qualitative breakthroughs (Zhang et al., 2023) [12]. Third, new quality productive forces prioritize industrial cultivation by leveraging strategic emerging and future industries. Digital industrialization and industrial digitization drive industrial upgrading and economic restructuring, fostering new quality productive forces through technological innovation (Shi et al., 2023) [13]. Finally, neither technology nor any individual factor of production alone constitutes productivity. They must be integrated and synergized with other factors to become effective productivity components. Hence, it is essential to cultivate a workforce proficient in new technologies, develop and produce advanced production tools, and create industries capable of absorbing and utilizing new technologies (Qiu, 2024) [7]. In summary, the formation of new quality productive forces follows the trajectory from scientific discovery and technological invention to the emergence of new industries, business models, and growth drivers. Its development aligns with the demands of the new technological revolution and responds to evolving global and domestic conditions, setting higher standards and directions for the future of productivity (Xu et al., 2024; Ren, 2024) [14,15].

Scholars have developed various metrics for measuring new quality productive forces based on their theoretical connotations, with differences primarily reflected in the measurement dimensions. Wang et al. (2024) [8] constructed a comprehensive evaluation system based on the three dimensions of new quality productive forces: laborers, labor objects, and production materials. Xu et al. (2024) [14] developed an alternative framework focusing on four dimensions: green output, the talent supply system, the economic support system, and the future industrial development system. Regarding index aggregation methods, most scholars employ the entropy method, an objective approach to dimensionality reduction for high-dimensional variables.

2.2. Influencing Factors and Measurement of High-Quality Development of Foreign Trade

The development of international trade has undergone three major phases: traditional final goods trade, global value chain or supply chain trade, and digital trade (Baldwin, 2011; Pei Changhong et al., 2020) [16,17]. In the early stages of China's reform and opening-up, the country leveraged its factor endowment advantages to integrate into the GVC system in a "low-end embedded" manner. However, a series of structural problems accumulated during the long period of rapid growth have also been exposed, including low quality and efficiency, insufficient indigenous innovation, an imbalanced economic structure, and severe environmental pollution, which have significantly constrained the sustainable development of China's economy and society (Luo et al., 2023) [18]. High-quality development emphasizes the organic integration of economic, social, and ecological benefits. It focuses not only on gross value as an indicator but also on a comprehensive assessment of eco-

nomic efficiency, structure, stability, and sustainability (Ren et al., 2019) [19]. This implies that achieving the high-quality development of foreign trade necessitates a fundamental transformation in trade development models. It requires adherence to new development philosophies, alignment with high-quality economic growth, and promotion of reforms and innovations across various sectors (Zhang et al., 2024) [20].

Regarding the connotation and influencing factors of high-quality development of foreign trade, Dai et al. (2018) [21] argued that it entails achieving external market diversification, improving internal industrial coordination, enhancing the competitiveness of value and quality, and fostering joint openness between manufacturing and service sectors. Qu et al. (2019) [22] found that the high-quality development of foreign trade is closely linked to all stages of production, distribution, and consumption. It is highly correlated with both domestic and international markets and serves as a concentrated reflection of a country's position within global industrial, supply, and value chains. Chen et al. (2021) [23] suggested that achieving the high-quality development of foreign trade requires substantial advancements in trade volume, technology, trade competitiveness, structure, and influence over international trade regulations. Some scholars have also identified human capital, foreign direct investment (FDI), economic policies, and the digital economy as direct factors influencing the high-quality development of foreign trade (Zhang et al., 2024; Wu et al., 2023; Di et al., 2023) [20,24,25].

In the early literature, research on the comprehensive measurement of foreign trade quality was limited. He (2011) [26] used the Analytic Hierarchy Process (AHP) to develop a comprehensive evaluation index for foreign trade quality, incorporating five dimensions: trade growth scale, trade structure, economic benefits, social benefits, and international competitiveness. Zhu et al. (2012) [27] further expanded this framework by adding two additional dimensions, foreign trade resource utilization efficiency and green trade development capacity, thereby enriching the connotation of foreign trade quality assessment. Following the introduction of the high-quality development theory, Qu et al. (2019) [22] assessed the state of high-quality development of foreign trade from five perspectives: foreign trade fundamentals, trade optimization, trade competitiveness, trade service integration, and status within international economic and trade regulations. Yang et al. (2023) [28] further refined these evaluation criteria by incorporating additional indicators such as trade resilience, the economic driving effect of trade, and the quality of traded goods. Beyond constructing target-based comprehensive evaluation indices, Wang et al. (2022) [29] applied the DEA-Malmquist model to measure trade efficiency and assess its impact on the high-quality development of foreign trade.

3. Theoretical Mechanisms and Research Hypotheses

The development of new quality productive forces is characterized by high technology, high efficiency, and high quality. Its essence lies in the evolution of productive forces through revolutionary technological breakthroughs, innovative allocation of production factors, and deep industrial upgrading and transformation. New quality productive forces encompass three dimensions: new quality laborers, new quality labor materials, and new quality labor objects. They emerge through an optimized and synergistic combination of these elements. The process can be summarized as new quality laborers utilizing new quality labor materials to act upon new quality labor objects, forming an interconnected and organically unified system. As the main agent, new quality laborers possess higher professional qualifications, and their cognitive, practical, and innovative abilities are superior to traditional workers, leading to a significant increase in labor productivity (Shi et al., 2024) [13]. As an important carrier, new quality labor materials are characterized by continuous technological evolution and disruptive innovations. The

digital attributes of the digital era give it new vitality, and artificial intelligence and other emerging labor materials promote qualitative changes in the mode of production division of labor and collaboration. As the recipient of labor, new quality labor objects include new natural resources, raw materials embedded with advanced technological elements, and intangible data. These elements emphasize globalization, digitalization, resource diversification, and sustainable development.

Meanwhile, the essence of high-quality development of foreign trade is to promote a more balanced and sufficient foreign trade structure (Dai et al., 2018) [21], which represents a new approach to advancing China's economic and social development. The traditional "low-end products, low quality, and large quantity" export model is no longer suitable for China's foreign trade transformation and the evolving international trade landscape. The current imperative is to achieve balanced development across regions, industries, and areas of economic openness, and transition toward high-end value chains, innovation-driven growth, and global governance capabilities. The development of new quality productive forces itself is in line with the inherent requirements of high-quality development of foreign trade, with the improvement of the level of domestic new quality productive forces, industrial transformation, and upgrading, the structure of foreign trade products more optimized, the market and cooperation become more open and secure, comprehensively driving high-quality development. Based on the above analysis, this paper proposes the following hypothesis:

Hypothesis 1: The development of new quality productive forces can enhance the level of high-quality development of foreign trade in China.

Through the previous analysis, it is found that factor matching, industrial division, and market competition may affect the high-quality development of foreign trade through the mediating effect:

First, new quality productive forces optimize factor matching, thereby driving the high-quality development of foreign trade. New quality productive forces achieve efficient allocation and combination of production factors through technological innovation and synergy among high-end factors. For example, factors such as highly educated labor, green capital, and cutting-edge technology synergize with the direction of modern industrial development, improving the efficiency of factor allocation. Meanwhile, new quality productive forces emphasize the optimized combination of laborers, labor materials, and labor objects, adjusting factor proportions and structures to enhance production efficiency and resource allocation precision, reduce costs, and strengthen foreign trade export capacity (Li et al., 2015) [30].

Second, new quality productive forces deepen industrial division, further driving the high-quality development of foreign trade. The development of new quality productive forces promotes greater segmentation and division in enterprise production processes, enhancing China's integration into the global value chain and deepening industrial division (Tan et al., 2024) [31]. The deepening of division enhances resource allocation and efficiency through specialized collaboration, thereby increasing trade benefits. Moreover, market division fosters the formation of nested and symbiotic industrial clusters along the supply chain, generating external economies of scale (Li et al., 2023) [32], which further promotes high-quality trade development.

Finally, new quality productive forces enhance market competitiveness, thereby driving the high-quality development of foreign trade. The new quality productive forces are centered on innovation, which enhances competitiveness and triggers healthy competition throughout the industry, and the advanced industrial system is an important foundation for market competitiveness (Li et al., 2023) [33]. Healthy competition en-

hances the quality of core export products, increasing their visibility in international markets, attracting a larger market share, and ultimately promoting high-quality trade development (Luo et al., 2023) [18].

Based on the above analysis, this paper proposes the following three mechanism hypotheses:

Hypothesis 2a: Factor matching exerts a mediating effect on the relationship between new quality productive forces and the high-quality development of foreign trade.

Hypothesis 2b: Industrial division exerts a mediating effect on the relationship between new quality productive forces and the high-quality development of foreign trade.

Hypothesis 2c: Market competition exerts a mediating effect on the relationship between new quality productive forces and the high-quality development of foreign trade.

4. Research Design and Indicator Measurement

4.1. Data Sources

Based on the availability of data, this study utilizes data from 330 samples across 30 provinces in China (excluding Hong Kong, Macao, Taiwan, and Tibet) from 2011 to 2021. The data primarily come from the China National Bureau of Statistics, the China National Customs Statistics Database, the WTO Database, the DRCNET Database, the CSMAR Database, the EPS Database, the IFR Database, the ICRG Database, Peking University's Digital Financial Inclusion Index, and the Provincial Marketization Index Database of China, as well as annual reports from listed companies and local government documents. Missing data is supplemented using interpolation methods.

4.2. Research Method

4.2.1. Entropy Method

To measure new quality productive forces and the high-quality development of foreign trade, this paper assigns weights to various indicators. Existing weighting methods are generally categorized into subjective and objective approaches. Subjective weighting approach relies on the perceived relative importance of indicators, but it may introduce personal bias and result in subjective distortions in the weight assignment. To avoid the disadvantages, this paper adopts the entropy method, an objective weighting technique that bases weights on the original information of indicators. Following Luo et al. (2023) [18], we first standardize the indicators.

$$\begin{cases} \textit{the positive indicators} : Y_{tj} = \dfrac{X_{tj} - \min\{X_j\}}{\max\{X_j\} - \min\{X_j\}} \\ \textit{the negative indicators} : Y_{tj} = \dfrac{\max\{X_j\} - X_{tj}}{\max\{X_j\} - \min\{X_j\}} \end{cases} \tag{1}$$

In the above equation, t and j represent the year and the different indicators. X_{tj} denotes the original value of the indicator, while $\min\{X_j\}$ and $\max\{X_j\}$ represent the minimum and maximum values of the indicator across all years. Y_{tj} is the standardized value. After standardization, the information entropy, entropy redundancy, and the weights of each indicator in the measurement system are calculated as follows:

$$e_j = -\frac{1}{\ln n} \sum_{t=1}^{n} \frac{X_{tj}}{\sum_{t=1}^{n} X_{tj}} \times \ln \frac{X_{tj}}{\sum_{t=1}^{n} X_{tj}} \tag{2}$$

$$d_j = 1 - e_j \tag{3}$$

$$\varphi_j = \frac{d_j}{\sum_{j=1}^{n} d_j} \tag{4}$$

In the above equation, n denotes the number of evaluation years, e_j represents the information entropy of indicator, d_j refers to the entropy redundancy, and ψ_j indicates the weight of the indicator derived from its entropy redundancy. Based on these calculated weights, the standardized indicators are aggregated to construct the index of new quality productive forces and the index of high-quality foreign trade development:

$$Z_t = \sum_{j=1}^{n} \varphi_j \times Y_{tj} \tag{5}$$

Based on the above formulas, the indices for new quality productive forces and high-quality foreign trade development are calculated, with values ranging from 0 to 1. A higher index value indicates a higher level of development in either new quality productive forces or the high-quality development of foreign trade, whereas a lower value reflects a lower level of development.

4.2.2. Model Construction

The high-quality development of foreign trade may exhibit strong path dependence and inertia, whereby the current level of trade quality is significantly influenced by its past level. Accordingly, this study incorporates the first-order lag of high-quality foreign trade development into a dynamic panel model to examine the impact of new quality productive forces on trade performance:

$$HQTrade_{it} = \lambda_0 + \lambda_1 HQTrade_{it-1} + \lambda_2 NQPro + \lambda_3 Control_{it} + \mu_i + \nu_t + \varepsilon_{it} \tag{6}$$

where i represents different provinces, t represents different years, *HQTrade* denotes the indicator for high-quality development of foreign trade, *NQPro* represents the indicator for new quality productive forces, and Control includes control variables. μ and ν denote province-fixed effects and time-fixed effects, respectively, while ε is the random disturbance term. Since the inclusion of the lagged dependent variable may introduce endogeneity, this study employs the System Generalized Method of Moments (System GMM) proposed by Arellano et al. (1991) [34] and Blundell et al. (1998) [35] to estimate the dynamic panel model.

To identify the mechanism through which new quality productive forces influence the high-quality development of foreign trade, this paper adopts the mediation effect test for validation and analysis. The traditional three-step mediation test is prone to endogeneity bias and unclear channel identification (Hayes, 2009; Jiang, 2022) [36,37]. Therefore, following the approach used by Wang et al. (2022) [38] and Song et al. (2023) [39], this paper employs a new three-step mediation testing method. The first step involves the main regression model, while the second step estimates the regression model between the explanatory variable and the mediating variable:

$$MED_{it} = \alpha_0 + \alpha_1 MED_{it-1} + \alpha_2 NQPro + \alpha_3 Control_{it} + \mu_i + \nu_t + \varepsilon_{it} \tag{7}$$

where *MED* represents the mediating variables, including factor matching, industrial division, and market competition. The third step estimates the regression model between the mediating variable and the dependent variable:

$$HQTRADE_{it} = \beta_0 + \beta_1 HQTRADE_{it-1} + \beta_2 MED_{it} + \beta_3 Control_{it} + \mu_i + \nu_t + \varepsilon_{it} \tag{8}$$

4.3. Variable Selection

Dependent Variable: the high-quality development of foreign trade (HQTrade). Based on the requirements of China's "14th Five-Year Plan for High-Quality Development of Foreign Trade" and the research of Yang et al. (2023) [28], this paper utilizes the entropy method to construct an indicator system for the high-quality development of foreign trade, which contains six first-level indicators and 12 s-level indicators (see Table 1). Strengthening foreign trade serves as a direct reflection of the high-quality development of foreign trade.

Table 1. Indicator System for the high-quality development of foreign trade.

Dimension	Primary Indicator	Secondary Indicator	Direction
high-quality development of foreign trade	Growing trade	Foreign Trade Growth Rate (%)	+
		TC Index (%)	+
	Innovative trade	Export Technological Complexity Index[1]	+
		Export Value of High-Tech Products	+
	Green trade	Green Trade Barriers (%)[2]	−
		Proportion of Green Trade Products (%)[3]	+
	Digital trade	E-commerce Sales Volume	+
		Digital Trade Policies (Frequency of Keywords)[4]	+
	Open trade	Foreign Trade Dependence (%)	+
		Number of Trade Partner Countries	+
	Secure trade	Trade Risk Index[5]	−
		Number of AEO-Certified Enterprises[6]	+

Explanatory Variable: New Quality Productive Forces (NQPro). The construction of the New Quality Productive Forces (NQPro) indicator system is based on the political economy understanding of productivity, focusing on the leap in the optimization combination of laborers, labor materials, and labor objects. It also incorporates the characteristics of NQPro as "high-tech, high-quality, high-efficiency, and advanced productive forces that align with the new development concept". Drawing on the indicator measurement methods from Wang Jue et al. (2024) [8], this paper utilizes the entropy method to reconstruct the indicator measurement system for NQPro, which includes three major dimensions, 15 primary indicators, and 33 secondary indicators, as shown in Table 2.

Table 2. Indicator System for New Quality Productive Forces.

Dimension	Primary Indicator	Secondary Indicator	Direction
New Quality Laborers	Human Capital Investment	Expenditure on Scientific Undertakings	+
		Expenditure on Education	+
	Human Capital Structure	Proportion of Employment in Emerging Industries[7]	+
		Proportion of R&D Personnel to Total Employment	+
	Human Capital Skills	Proportion of Employed Individuals with Higher Education (Associate Degree and Above)	+
		Labor Productivity[8]	+
	Human Capital Security	Per Capita Social Security Employment Investment	+
		Unemployment Rate	−
New Quality Labor Materials	Technological Innovation Level	Number of Patents Authorized per Capita	+
		R&D Expenditure of Above-Scale Industrial Enterprises	+
	Technical Cooperation and Mobility Level	Transaction Volume in the Technology Market	+
		Number of Patents Held by Industry-Academia-Research Enterprises	+
	Transportation Infrastructure	Highway Mileage	+
		Operating Railway Mileage	+
	Telecommunications Infrastructure	Number of Internet Broadband Access Ports	+
		Length of Optical Fiber Cable	+
	Energy Consumption Level	Total Energy Consumption	−
		Proportion of Renewable Energy (Non-Hydroelectric) in Total Power Generation	+
	Level of Production Intelligence	Density of Industrial Robot Installation[9]	+
		Number of Computers Used per 100 People	+

Table 2. *Cont.*

Dimension	Primary Indicator	Secondary Indicator	Direction
New Quality Labor Objects	Development of Emerging Industries	Total Assets of Strategic Emerging Industries	+
		Level of High-Tech Industry[10]	+
		Number of Specialized, Refined, Unique, and Innovative Enterprises	+
	Upgrading of Traditional Industries	Sales Revenue from New Products	+
		Proportion of Industry Structure Upgrading	+
	Layout of Future Industries	Frequency of Policy Documents[11]	+
		Number of Major National Research Program Projects[12]	+
	Low-Carbon Green Development	Carbon Emissions	−
		Comprehensive Utilization of General Industrial Solid Waste	+
		Green Transformation (Keyword Frequency)[13]	+
	Development of Digital Economy	Employment in Information Transmission, Software, and IT Services in Urban Units	+
		Development of Digital Inclusive Finance (Index)	+
		Digital Transformation (Keyword Frequency)	+

Mediating Variable: (1) Factor Matching. Drawing on Hsieh et al. (2009) [48], a C-D production function is used to measure the factor mismatch index, and the factor matching index is derived by taking the reciprocal of this index. The formula for calculating the factor mismatch index is as follows:

$$dist = dist_k^{\alpha/(\alpha+\beta)} dist_l^{\beta/(\alpha+\beta)} \tag{9}$$

$$Match = ln(1/dist) \tag{10}$$

"Dist" represents the factor distortion index, with "distk" and "distl" representing the distortion indices for capital and labor factors. The reciprocal of the factor distortion index is logarithmically transformed to represent the factor matching index, with a higher index indicating a greater degree of factor matching.

(2) Industrial division. Long et al. (2021) [49] used the average production length as a measure of the degree of division. Compared to processing trade, general trade has more complex relationships with both domestic and international upstream and downstream sectors. Yi et al. (2018) [50] argued that as the global Industrial division deepens, the proportion of China's processing trade exports continues to decrease, while the share of general trade increases. Therefore, this paper uses the proportion of general trade export value in total exports as a measure of the degree of Industrial division. A higher value of this indicator indicates a greater degree of division of Industrial.

(3) Market Competition. Strengthening market competition can reduce production costs for enterprises, but as the proportion of management and sales expenses increases, various expenditures, such as advertising, marketing, and maintenance services, also gradually rise (Tang et al., 2023) [51]. Therefore, this paper uses (Selling Expenses + Administrative Expenses)/Operating Revenue of the above-sized enterprises to represent market competition. A higher value indicates more intense market competition.

Control Variables: In selecting control variables, this paper avoids overlap with the measurement indicators of core variables. Five control variables that may influence the high-quality development of foreign trade are chosen: population size, consumption level, financial development level, marketization level, and the proportion of state-owned assets. Population size (Inpop) is represented by the logarithm of the resident population at the end of the year. Consumption level (Consume) is represented by the proportion of total retail sales of consumer goods to gross domestic product (GDP). Financial development level (Finance) is represented by the proportion of the loan balance of financial institutions to GDP at the end of the year. Marketization level (Market) is represented by the marketiza-

tion index measured by the Beijing National Economic Research Institute. The proportion of state-owned assets (State) is represented by the proportion of total assets controlled by state-owned enterprises in industrial enterprises above a certain scale.

Descriptive Statistics of Core Variables, Mediating Variables, and Control Variables are presented in Table 3.

Table 3. Descriptive Statistics of Variables.

Variable Category	Variable Name	Symbol	Sample Size	Mean	Standard Error	Min	Max
Dependent Variable	High-Quality Development of Foreign Trade	HQTrade	330	0.1103	0.1011	0.0224	0.9178
Independent Variable	New Quality Productive Forces	NQPro	330	0.1661	0.1092	0.027	0.7365
	Factor Matching	Matching	330	1.5216	0.8286	−0.2995	4.6323
Mediating Variables	Industrial Division	Division	330	0.698	0.2089	0.2612	0.9996
	Market Competition	Competition	330	0.0712	0.0155	0.0378	0.1108
Control Variables	Population Size	Inpop	330	8.208	0.7366	6.3424	9.4481
	Financial Development Level	Finance	330	1.3356	0.5042	0.4064	4.7705
	Consumption Level	Consume	330	0.3801	0.0683	0.222	0.5384
	Marketization Level	Market	330	8.0391	1.9136	3.359	12.39
	Proportion of State-Owned Assets	State	330	0.4738	0.1673	0.1387	0.8267

5. Empirical Results and Analysis

5.1. Main Regression

Table 4 reports the main regression results on the impact of new quality productive forces on the high-quality development of foreign trade. First, the significantly positive coefficients on the lagged term of high-quality development of foreign trade (L.HQTrade) in Table 4 indicate strong hysteresis characteristics, which proves that the selection of dynamic panel model is reasonable. Second, the Arellano–Bond test for autocorrelation shows a low p-value for the first-order difference term and a high p-value for the second-order term, suggesting the presence of first-order, but not second-order, autocorrelation in the differenced residuals and no autocorrelation in the level equation. Furthermore, the Sargan test for instrument validity yields p-values above 0.99, indicating that the null hypothesis of valid instruments cannot be rejected. Together, these diagnostics confirm the appropriateness of the system GMM estimator used in this paper.

Column (1) reports the results without control variables, showing that the coefficient of new quality productive forces is 0.210 and is statistically significant at the 1% level. Column (2) includes control variables, and the coefficient of new quality productive forces remains significantly positive at the 1% level. These results indicate that new quality productive forces have a significant promoting effect on the high-quality development of foreign trade, thus validating Hypothesis 1. Columns (3) to (8) of Table 4 present the regression results for the impact of different dimensions of new quality productive forces on the high-quality development of foreign trade. Columns (3), (5), and (7) report the results for new quality laborers, new quality labor materials, and new quality labor objects, respectively, without control variables. Columns (4), (6), and (8) present the results after adding control variables. The results show that all three dimensions of the new quality productive forces significantly promote the high-quality development of foreign trade. This finding suggests that, first, improvements in the level of new quality laborers contribute to the high-quality development of foreign trade. Enhancing workforce division and innovation capacity, improving skill levels, and increasing labor security can enhance the efficiency of labor and capital allocation. Additionally, the upgrading of human capital continuously strengthens industrial trade competitiveness, making it a crucial factor influencing the high-quality development of foreign trade. Second, improvements in the level of new

quality labor materials promote the high-quality development of foreign trade. The adoption of intelligent and digital production tools, along with more advanced infrastructure and production environments, enhances operational efficiency and innovation capacity. This allows businesses to better meet international market demands for higher product quality, functionality, and environmental standards, thereby fostering the high-quality development of foreign trade. Finally, the enhancement of new quality labor objects contributes to the high-quality development of foreign trade. The technological, digital, and green transformation of industries is a dynamic process that improves productivity and efficiency. It also drives trade development toward innovation, integration, digitalization, and sustainability, serving as a new driving force for the high-quality development of foreign trade. The analysis of the impact of different dimensions of new quality productive forces provides valuable insights into regional and industrial strategies in fostering new quality productive forces.

Table 4. Main Regression Results.

Variable	(1) HQTrade	(2) HQTrade	(3) HQTrade	(4) HQTrade	(5) HQTrade	(6) HQTrade	(7) HQTrade	(8) HQTrade
L.HQTrade	0.929 ***	0.743 ***	1.023 ***	1.052 ***	0.903 ***	0.654 ***	0.987 ***	0.943 ***
	(79.503)	(21.735)	(104.481)	(45.971)	(144.544)	(14.546)	(92.881)	(35.859)
NQPro	0.210 ***	0.317 ***						
	(19.364)	(13.996)						
NQLabor			0.919 ***	0.744 ***				
			(8.129)	(3.407)				
NQMean					0.633 ***	1.035 ***		
					(47.292)	(11.963)		
NQObject							0.277 ***	0.317 ***
							(14.140)	(11.353)
Inpop		0.019 ***		−0.014		0.025 ***		0.006
		(2.866)		(−0.866)		(3.149)		(1.140)
Finance		0.005 **		0.007 ***		0.010 ***		0.004 **
		(2.078)		(3.463)		(2.959)		(1.990)
Consume		−0.007		−0.073 ***		0.003		−0.014
		(−0.321)		(−3.799)		(0.118)		(−0.546)
Market		−0.003 ***		−0.006 ***		−0.003 **		−0.004 ***
		(−4.002)		(−5.689)		(−2.262)		(−3.377)
State		−0.069 ***		−0.051 **		−0.076 ***		−0.061 **
		(−2.686)		(−2.201)		(−3.109)		(−2.045)
Constant Term	−0.004 ***	−0.095	−0.011 ***	0.187	−0.008 ***	−0.145 **	0.004 ***	0.013
	(−3.768)	(−1.550)	(−4.096)	(1.480)	(−4.835)	(−2.141)	(4.771)	(0.268)
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Province FE	YES	YES	YES	YES	YES	YES	YES	YES
AR(1) P	0.013	0.019	0.010	0.006	0.009	0.014	0.014	0.013
AR(2) P	0.536	0.526	0.526	0.505	0.567	0.518	0.528	0.502
Sargan test	0.678	0.925	0.587	0.994	0.538	0.948	0.767	0.949
N	300	300	300	300	300	300	300	300

Note: z-values are shown in parentheses. *** and ** represent 1% and 5% significance coefficient tests, respectively.

5.2. Endogeneity and Robustness Tests

5.2.1. Endogeneity Test

Although the system GMM is able to correct for unobserved heteroskedasticity problems, omitted variable bias, measurement error, and potential endogeneity problems, residual endogeneity concerns may still persist. Specifically, two sources of endogeneity remain. First, there may be a bidirectional causal relationship between new quality productive forces and the high-quality development of foreign trade. On the one hand, advances in new quality productive forces may promote high-quality trade development through industrial upgrading and technological innovation. On the other hand, improvements in foreign trade performance may in turn foster the growth of new quality productive forces via mechanisms such as foreign capital inflow and innovation incentives, leading to simultaneity bias. Second, the development of new quality productive forces is often closely associated with regional factors, including the industrial foundation, policy environment, and human capital. Meanwhile, some unobserved heterogeneity may lead to omitted variable bias, which could potentially undermine the accuracy and robustness of the empirical results.

To address potential bidirectional causality, the analysis follows Li et al. (2020) [52] by regressing current new quality productive forces on lagged high-quality trade development and extracting the residual term (R_NQPro). This residual captures the exogenous component of new quality productive forces that is orthogonal to prior trade performance. Re-estimating the model using R_NQPro as the explanatory variable helps isolate the causal effect. As shown in Column (1) of Table 5, the coefficient on R_NQPro remains significantly positive at the 1% level, suggesting that the core findings are robust after accounting for reverse causality.

Table 5. Endogeneity and Robustness Test Results.

Variable	(1) HQTrade	(2) 2SLS (1st Step)	(3) 2SLS (2nd Step)	(4) PCA (Independent Variable)	(5) PCA (Dependent Variable)	(6) Low-Level NQPro	(7) High-Level NQPro	(8) Lagged Control Variables
L.HQTrade	1.169 ***			0.844 ***	0.107 *	0.694 ***	0.535 *	0.844 ***
	(105.330)			(15.578)	(1.851)	(7.491)	(1.915)	(21.049)
R_NQPro	0.099 ***							
	(3.096)							
IV_NQPro		0.286 ***						
		(4.28)						
NQPro			0.656 ***	0.051 ***	3.553 ***	0.394 ***	0.325	0.256 ***
			(6.256)	(5.522)	(5.217)	(8.752)	(1.425)	(8.278)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Lagged 1 period
Constant Term	0.136 ***			−0.176 ***	−1.384	−0.099	−0.066	−0.117 ***
	(4.112)			(−2.620)	(−1.412)	(−0.406)	(−1.205)	(−3.025)
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Province FE	YES	YES	YES	YES	YES	YES	YES	YES
AR(1) P	0.009			0.007	0.023	0.091	0.0782	0.020
AR(2) P	0.509			0.557	0.325	0.258	0.959	0.502
Sargan test	0.854			0.958	0.863	0.999	1.000	0.960
KP rk LM statistic			18.096					
			0.000					
KP rk Wald F statistic			18.361					
			{16.38}					
N	300	330	330	300	300	137	140	300

Note: z-values are shown in parentheses. *** and * represent 1% and 10% significance coefficient tests, respectively.

To further mitigate potential endogeneity, a two-stage least squares (2SLS) approach is employed using an external instrumental variable. Specifically, the weighted average of new quality productive forces in three non-contiguous provinces with similar economic scale is constructed as the instrument (IV_NQPro) for each target province. Provinces with comparable economic size are likely to share similar industrial structures, technological capabilities, and human capital inputs, thereby satisfying the relevance condition. Excluding geographically adjacent provinces helps to reduce the interference caused by spatial spillover effects and common shocks (such as policy spillovers, regional linkage effects, or the transmission of natural disasters). This makes new quality productive forces in these provinces more likely to be independent of the high-quality development of foreign trade in the target provinces, thereby meeting the exogeneity requirement. As shown in Column (2) of Table 5, the coefficient on IV_NQPro is significantly positive at the 1% level, and the KP rk Wald F-statistic is 18.361, which is well above the 10% critical value of 16.380 suggested by Stock and Yogo (2002) [53], thus indicating that weak instrument bias is unlikely. The second-stage regression results in Column (3) also reveal a significantly positive coefficient on NQPro at the 1% level, with the KP rk LM statistic also significant at the 1% level, confirming that the instrument passes the underidentification test. These findings provide further evidence supporting the robustness of the baseline results.

5.2.2. Robustness Tests

Columns (4)–(8) of Table 5 report the robustness test results. Three approaches are employed to examine the robustness of the findings:

Replacing the core variables. Since both new quality productive forces and the high-quality development of foreign trade are composite indicators, substituting them with a single indicator may introduce bias. To address this, the principal component analysis (PCA) method is used to remeasure both variables before replacing and re-estimating them in the regressions. As shown in Columns (4)–(5), regardless of whether the independent or dependent variable is replaced, new quality productive forces remain significantly positive at the 1% level in promoting the high-quality development of foreign trade.

Subsample regression. The sample is divided into two groups—low-level and high-level new quality productive forces—based on the mean value, and separate regressions are conducted for each subgroup. The results, shown in Columns (6)–(7), indicate that new quality productive forces significantly promote the high-quality development of foreign trade in both groups. The only difference lies in the magnitude of the coefficients, with the low-level group exhibiting a stronger effect.

Lagging control variables. The control variables are lagged by one period and incorporated into the regression. The results continue to show that new quality productive forces significantly promote the high-quality development of foreign trade.

The robustness test results collectively confirm that the positive effect of new quality productive forces on the high-quality development of foreign trade remains robust.

5.3. Mediation Effect Analysis

The empirical tests above have confirmed that new quality productive forces significantly promote the high-quality development of foreign trade. Based on the previous analysis of the impact mechanisms, this study identifies three mediating channels: factor matching, industrial division, and market competition. Following Equations (7) and (8), this section primarily examines the relationship between the explanatory variable and the mediating variables to validate the mechanism through which new quality productive forces foster the high-quality development of foreign trade. The results of the mechanism tests are presented in Table 6. Columns (1) and (2) of Table 6 show that new quality productive forces have a significantly positive effect on factor matching at the 1% level, and that factor matching also positively influences the high-quality development of foreign trade at the 1% level. This suggests that new quality productive forces enhance the rationality of factor allocation. This improvement facilitates the efficient coordination of capital, labor, and technology, fostering industrial development and providing strong support for high-quality foreign trade. As shown in Columns (3) and (4) of Table 6, new quality productive forces have a significantly positive effect on industrial division at the 5% level, and that industrial division also positively influences the high-quality development of foreign trade at the 5% level. This indicates that the new quality productive forces can promote the deepening of the industrial division. It can give better play to the comparative advantage through the specialization of the division of industrial. In addition, it can enhance the competitiveness and resilience of the industrial chain and is also conducive to the high-quality development of foreign trade. Columns (5) and (6) of Table 6 show that new quality productive forces have a significantly positive effect on market competition at the 5% level, and that market competition likewise significantly promotes the high-quality development of foreign trade at the 1% level. From a theoretical perspective, new quality productive forces intensify market competition. This compels domestic industries to continuously introduce new and high-quality products to maintain their market position. As a result, it promotes the development of high-quality foreign trade. These results confirm Hypotheses 2a, 2b, and 2c, demonstrating that new quality

productive forces indeed facilitate the high-quality development of foreign trade through the channels of factor matching, industrial division, and market competition.

Table 6. Mediation Effect Test Results.

Variable	(1) Matching	(2) HQTrade	(3) Division	(4) HQTrade	(5) Competition	(6) HQTrade
Lag term	0.491 ***	1.010 ***	0.675 ***	1.062 ***	0.650 ***	1.117 ***
	(11.983)	(57.221)	(5.140)	(46.267)	(3.533)	(46.060)
Matching		0.006 ***				
		(2.598)				
Division				0.018 **		
				(2.220)		
Competition						0.029 ***
						(2.948)
NQPro	3.034 **		0.940 **		0.295 **	
	(2.571)		(2.073)		(2.042)	
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Constant Term	−6.458 ***	−0.074	2.259	−0.037	0.264	0.150 **
	(−4.270)	(−1.436)	(1.596)	(−0.839)	(0.921)	(1.983)
Year FE	YES	YES	YES	YES	YES	YES
Province FE	YES	YES	YES	YES	YES	YES
AR(1) P	0.046	0.011	0.011	0.003	0.024	0.006
AR(2) P	0.286	0.444	0.131	0.783	0.226	0.747
Sargan test	1.000	0.938	0.999	0.991	1.000	0.828
N	300	300	300	300	300	300

Note: z-values are shown in parentheses. *** and ** represent 1% and 5% significance coefficient tests, respectively.

5.4. Heterogeneity Analysis

To explore the differences in the impact of new quality productive forces on the high-quality development of foreign trade across regions, policies, and resources, this section conducts heterogeneity tests to further investigate these effects. The results of the tests are presented in a more intuitive forest plot (see Figure 1).

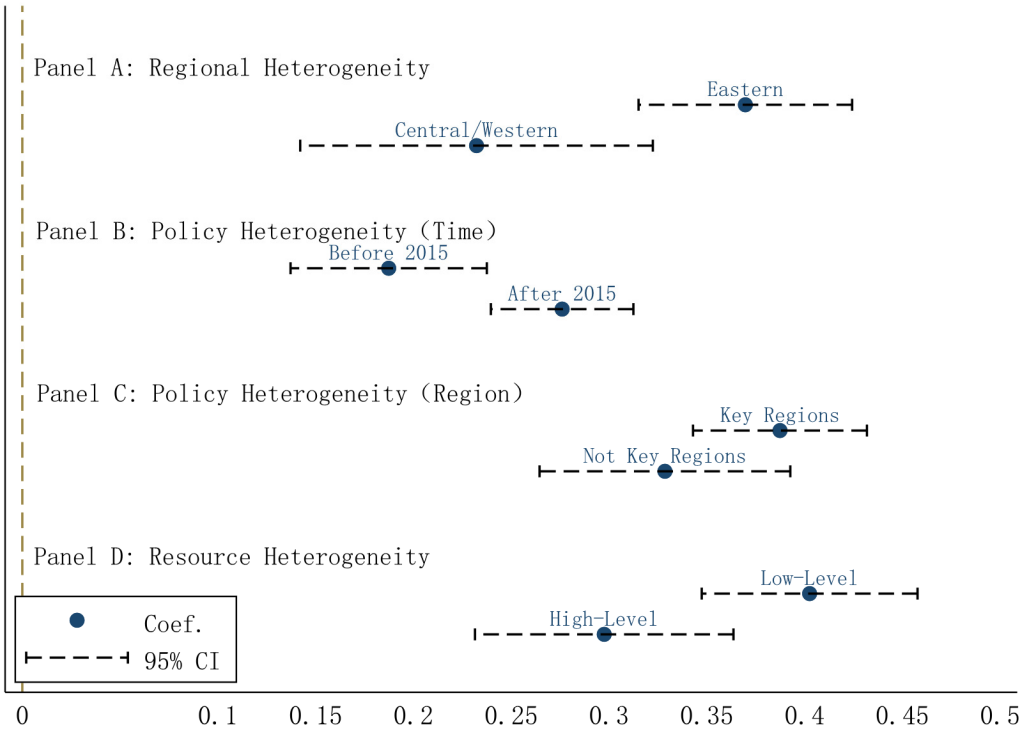


Figure 1. Heterogeneity Test Results.

5.4.1. Regional Heterogeneity

To examine whether the impact of new quality productive forces on the high-quality development of foreign trade differs across regions, this study divides the sample into the eastern and central/western regions for regression analysis. The results, shown in Panel A of Figure 1, indicate that the coefficients of new quality productive forces are significantly positive for both regions, but the promotion effect on the high-quality development of foreign trade in the eastern region is significantly higher than that in the central and western regions. This may be because the eastern region invested in foreign trade development early during the reform and opening-up period having a more mature foreign trade system and experience. Compared to the central/western regions, the eastern region has experienced faster industrial development, more intense market competition, and better connectivity with international markets due to abundant port resources and maritime transportation conditions. Therefore, the enhancement of new quality productive forces in the eastern region is more likely to facilitate the high-quality development of foreign trade compared to the central/western regions.

5.4.2. Policy Heterogeneity

To investigate the heterogeneous effects of policy measures, especially the "Belt and Road Initiative" (BRI) development policies, this study conducts heterogeneity analysis from both temporal and spatial perspectives. The regression results are presented in Panel B and Panel C of Figure 1. Temporally, the "Belt and Road Initiative" was proposed in 2013, but it officially took effect in 2015. Therefore, this study uses 2015 as the cutoff year for grouping. The results in Panel B show that before the BRI's implementation, the coefficient of new quality productive forces was significantly positive, but it was smaller in value compared to that after the implementation of the BRI. Spatially, the study groups provinces based on the 18 provinces identified in the 2015 joint document issued by the National Development and Reform Commission, Ministry of Foreign Affairs, and Ministry of Commerce of China, titled "Vision and Action for Promoting the Joint Construction of the Silk Road Economic Belt and the 21st Century Maritime Silk Road". The results in Panel C indicate that the coefficient of new quality productive forces remains significantly positive, and its impact on the high-quality development of foreign trade is notably stronger in the BRI provinces compared to non-key BRI provinces. The "Belt and Road Initiative" has played a significant role in promoting international cooperation, leading to a deeper division of labor and facilitating industrial transformation and upgrading as well as regional coordinated development. Moreover, the initiative has successfully expanded overseas markets and trade channels. A notable example is the opening of the China-Europe Railway Express. This has greatly improved the export conditions of inland regions. As a result, it has brought benefits to the high-quality development of foreign trade.

5.4.3. Resource Heterogeneity

Natural resource endowments can provide regions with a "resource dividend," but they can also lead to a "resource curse" due to inefficiencies. To explore the differences in the impact of new quality productive forces on the high-quality development of foreign trade across different resource endowments, this study divides the sample into high-resource-endowment and low-resource-endowment groups. The grouping is based on the 126 resource-based cities identified in the "National Resource-Based City Sustainable Development Plan (2013–2020)" issued by the State Council, with the total GDP of cities within the same province summed up and the share of each province's GDP calculated. The regression results, shown in Panel D of Figure 1, indicate that the coefficient of new quality

productive forces is significantly positive in both groups, but its positive impact on the high-quality development of foreign trade is much greater in the low-resource-endowment group than in the high-resource-endowment group. Regions with high resource endowments tend to be more dependent on resources, have relatively simple industrial structures, and face greater constraints on sustainable and green development. In contrast, low-resource-endowment regions are less constrained by development factors due to advancements in new energy, new materials, and new technologies. Their industrial structures are also more diversified. Therefore, the enhancement of new quality productive forces in low-resource-endowment regions is more effective in accelerating the high-quality development of foreign trade.

6. Conclusions and Recommendations

This study employs panel data from 30 provinces in China from 2011 to 2021 and applies the entropy method to measure both new quality productive forces and the high-quality development of foreign trade. Subsequently, a dynamic panel model is constructed, and the SYS-GMM is used to conduct an empirical analysis to examine the impact of new quality productive forces on the advancement of high-quality foreign trade. The key findings are as follows:

(1) New quality productive forces significantly promote the development of high-quality foreign trade. In the composition of new quality productive forces, the level of new quality laborers will be raised to improve the efficiency of factor use and enhance the competitiveness of trade through the upgrading of human capital. The advancement of new quality labor materials, driven by improved infrastructure and R&D environments, enhances operational efficiency and innovation capacity, aligning with international market demands. Additionally, the development of new quality labor objects fosters industrial transformation toward high-tech, digital, and green industries, injecting new momentum into trade development. All three dimensions play a crucial role in advancing high-quality foreign trade.

(2) Factor matching, industrial division, and market competition serve as mediating mechanisms through which new quality productive forces enhance high-quality foreign trade. The development of new quality productive forces optimizes the allocation and coordination of production factors, thereby improving production efficiency. It also deepens industrial specialization, leveraging comparative advantages to strengthen the competitiveness and resilience of supply chains. Furthermore, the advancement of new quality productive forces intensifies market competition, compelling domestic industries to introduce new products and enhance product quality, ultimately driving the high-quality development of foreign trade.

(3) The impact of new quality productive forces on the high-quality development of foreign trade is more pronounced in the eastern region, provinces under the Belt and Road Initiative, and low-resource-endowment regions. In the more economically developed eastern region, strong industrial foundations and concentrated innovation resources facilitate this effect. With the implementation of the BRI, increased trade cooperation opportunities and expanded market access further strengthen the impact. Additionally, provinces with lower resource endowments face a pressing need for transformation through innovation-driven strategies. As a result, in these regions, new quality productive forces, characterized by high technology and efficiency, serve as a strong driver of the high-quality development of foreign trade.

Based on the preceding analysis and conclusions, this study proposes the following policy recommendations:

(1) Enhance factor allocation efficiency and accelerate the development of new quality productive forces. This can be achieved by optimizing the human capital structure, improving labor quality, and strengthening the hierarchical cultivation of talent, which increases the number of workers with specialized knowledge and skills in fundamental and critical fields. Encourage enterprises to invest in technological innovation and research and development, especially in key areas, strengthen cooperation with universities and research institutions, promote the integration of industry, academia, and research, and improve the efficiency of the application and dissemination of high-tech new materials of production. This would enhance the application and dissemination of new technologies and production materials. Furthermore, efforts should be made to facilitate the transformation and upgrading of traditional industries, accelerate the development of digital technologies and strategic emerging industries, and actively nurture future industries.

(2) Address regional development disparities and reduce interregional gaps. Although the level of new quality productive forces in central and western China is relatively low, enhancing their development is crucial for advancing foreign trade. This can be achieved by guiding investment and optimizing industrial structures to elevate the level of new quality productive forces in these regions. Meanwhile, northeastern China, with its strong industrial foundation and well-established supply chains, plays a key role in the construction of a modern industrial system. However, the region faces development bottlenecks that require the adoption of new quality productive forces. By creating a conducive business environment, deepening both domestic and international openness, fostering emerging industries, and promoting the integration of technology and industry, the northeastern region can enhance its new quality productive forces and achieve comprehensive revitalization.

(3) Embrace technological, green, and digital transformation to drive the high-quality development of foreign trade. Technological innovation and R&D should be promoted to improve product quality, production efficiency, and competitiveness. Adhering to green production principles can enhance resource utilization efficiency, reduce waste emissions, and facilitate the establishment of green supply chains. Leveraging digital technologies and internet platforms can optimize foreign trade processes and management, increasing efficiency and convenience. By adopting these technological, green, and digital strategies, foreign trade enterprises can enhance their innovation capacity, environmental awareness, and digitalization levels, thereby achieving the high-quality development and remaining competitive in a globalized market.

(4) Further enhance openness and foster new momentum for the high-quality development of foreign trade. International cooperation and technological exchange should be encouraged to facilitate technology transfer and innovation collaboration, thereby improving product quality and competitiveness. The development of cross-border e-commerce and digital trade should be strengthened, leveraging the internet and e-commerce platforms to expand international trade volume and promote the high-quality development of foreign trade. Additionally, economic and trade cooperation with Belt and Road Initiative countries and regions should be reinforced to expand market opportunities and improve trade facilitation. Aligning with the CPTPP (Comprehensive and Progressive Agreement for Trans-Pacific Partnership) and promoting the high-quality implementation of the RCEP (Regional Comprehensive Economic Partnership) will help localities, industries, and enterprises expand international trade cooperation, advance institutional openness at a higher level, and inject new momentum into foreign trade development.

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Conflicts of Interest: The authors declare no conflict of interest.

Notes

1 Referencing Hausmann et al. (2007) [40] to calculate the export technology complexity index.
2 Match the HS6 codes of TBT measures published in the WTO Environmental Database with provincial export data and calculate the proportion.
3 Referencing Wang et al. (2021) [41], we classify the clean industry and products to calculate their trade share.
4 Referencing Duan et al. (2023) [42], we conduct keyword frequency statistics on policy documents.
5 Calculate the weighted risk index using ICRG country risk data and provincial trade shares with countries exceeding 100 million USD in trade.
6 AEO enterprise certification is the highest credit rating of the Customs, which is used to ensure the security of global trade, data from the Chinese Customs website manual statistics.
7 Data on strategic emerging industries is aggregated from listed companies in the China Strategic Emerging Industries Composite Index, excluding ST-designated and financial firms.
8 Referencing Delmas et al. (2012) [43] by dividing the value added of industrial enterprises above large scale by the average number of workers employed in the industry.
9 Referencing the industrial robot installation density calculation method by Du et al. (2022) [44].
10 Referencing Liang et al. (2024) [45], the ratio of high-tech industry value added to industrial value added is used to represent.
11 Based on the Implementation Opinions on Promoting Future Industries, 63 keywords were extracted, and their frequency in local policies was analyzed.
12 Major national research programs drive future industries by addressing strategic needs and scientific frontiers. Data is manually collected.
13 The green transformation and digital transformation are referenced from Zhou et al. (2022) [46] and Xu et al. (2023) [47], with keyword frequency statistics derived from corporate annual reports.

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