

Research on the Impact of the Belt and Road Initiative on the Quality of China's Manufacturing Export Products

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Abstract

This paper focuses on the impact of the Belt and Road Initiative on the quality of China's manufacturing exports as its core research topic. Integrating three major disciplines—international trade, industrial economics, and econometrics—it constructs a theoretical analytical framework and an empirical testing model to examine the intrinsic relationships across three dimensions: policy transmission mechanisms, firm response behaviors, and export quality outcomes. Utilizing export product data by industry from Chinese Customs for 2015 – 2024, industrial enterprise databases, and innovation survey data, the study establishes a panel sample covering 6,784 manufacturing firms, 37 export destination countries, and a ten-year observation period. Policy effects are quantified using indicators such as policy participation intensity, market diversification index, and technology investment proportion, with mechanism and path tests conducted using fixed-effects models, instrumental variable methods, and mediation effect models. The findings reveal that the Belt and Road Initiative significantly enhances the quality of manufacturing exports through trade facilitation, with mechanisms involving promotion of market diversification and incentives for technological investment. Notably, the policy effects differ markedly between capital-intensive sectors (e.g., automotive and shipbuilding) and labor-intensive sectors (e.g., textiles and home appliances). Analysis demonstrates that policy-driven market diversification and capacity restructuring play a pivotal role in high-quality development, and that strategic adjustments aligned with policy directions can foster long-term competitive advantages in international markets. This study not only validates the significant value of the Belt and Road Initiative in promoting quality upgrading but also provides a theoretical foundation for formulating more targeted open-economy policies and industrial support measures.

Keywords: Belt and Road Initiative; manufacturing exports; product quality; market diversification; technological investment

1 Introduction

1.1 Research Background: The Manufacturing Transformation from "Scale Expansion" to "Quality-Oriented"

With the profound restructuring of the global economy, China's manufacturing sector is at a critical stage of transitioning from "scale expansion" to "quality-oriented" development. For a long time, China's manufacturing industry's reliance on low-cost production and economies of scale has granted it significant competitive advantages in international trade. However, this cost-driven competition model has gradually revealed numerous shortcomings, including low product value-added, limited technological sophistication, and inadequate brand image. As global industrial chains evolve toward higher-end, more refined, and environmentally sustainable directions, this over-reliance on mass production can no longer meet these demands. Meanwhile, international market demand structures are upgrading, with consumers demanding higher standards for product quality, functionality, and innovation. The deepening of globalization has also provided emerging countries' manufacturing sectors with opportunities to

catch up and even surpass their competitors. In response to these challenges, China's manufacturing industry urgently needs to shift from traditional scale-expansion competition to a quality-driven strategic approach to enhance its core product competitiveness.

The Belt and Road Initiative provides crucial policy support and market expansion opportunities for the quality transformation of China's manufacturing sector. By promoting infrastructure connectivity, enhancing policy coordination, and fostering economic and trade cooperation, this initiative has directly influenced the demand structure for high-quality products in countries along the route. Meanwhile, relevant Belt and Road policies have lowered barriers for enterprises entering international markets, opening up vast market prospects for manufacturing companies. Regions such as Southeast Asia and Central Asia are experiencing accelerated economic growth, becoming new markets for Chinese manufacturers to explore. These countries possess relatively weak manufacturing foundations, yet consumer demand for high-quality, differentiated products continues to rise annually, offering Chinese enterprises opportunities for differentiated competition. Additionally, these regions generally benefit from labor advantages and abundant natural resources, while improved infrastructure investment has strengthened industrial chain integration, laying a solid

foundation for localized operations by manufacturing firms. Furthermore, the implementation of international trade rules under the Belt and Road Initiative has significantly reduced tariff barriers and trade costs while markedly enhancing trade facilitation, providing robust policy support for enterprises seeking to enhance product quality in overseas markets.

The study found that trade policy is not only a tool for market expansion but also a significant influencing factor in corporate strategic adjustments. Based on an analysis of existing literature, the Belt and Road Initiative has significantly impacted the market preference choices and strategic positioning of China's manufacturing sector through a series of trade facilitation policies and financial support. In participating in the Belt and Road policies, enterprises have not only expanded their geographical market coverage but also placed greater emphasis on the demand characteristics of consumers in emerging markets, thereby fostering their willingness to engage in differentiated production. Specifically, these policies have driven a shift in foreign trade competition from low-cost rivalry toward high technology and high quality. For example, companies have leveraged the logistics support provided by the Belt and Road Initiative to further optimize global supply chains and develop customized services, demonstrating the profound impact of these policies on enterprises' choices regarding quality enhancement pathways. The realization of policy benefits has not only incentivized enterprises to improve export product quality but also laid the financial and market foundations for technological investment and R&D collaboration. This effect is particularly pronounced in capital-intensive industries such as automotive manufacturing and machinery equipment.

Under the geopolitical context, internationalization opportunities have significantly enhanced the strategic overseas expansion of China's manufacturing sector. Supported by policies aimed at coordinating the geopolitical economy, Chinese enterprises have not only expanded their market reach through exports but also participated in infrastructure development and capacity cooperation along the Belt and Road routes to achieve continuous upgrading of industrial chains. These enterprises not only fulfill the national strategic goal of transitioning toward high-quality development but have also established a quality image of "China Manufacturing" in overseas markets. For instance, the textile industry's presence in Southeast Asia has comprehensively elevated the market value of exported textiles by promoting green production technologies and quality certification mechanisms. Meanwhile, the shipbuilding industry has optimized production processes and raised technical standards for core components through international cooperation agreements guided by the Belt and Road Initiative, thereby securing a technological leadership position in global competition. This demonstrates that geopolitical economic policies play a crucial role in driving enterprises' quality-oriented transformation.

In summary, the growing demand for manufacturing transformation in China aligns closely with the policy support of the Belt and Road Initiative, providing a crucial practical context and theoretical reference for this study. This research focuses on the mechanism by which the Belt and Road Initiative enhances the export quality of China's manufacturing sector. By examining how enterprises respond to market diversification, capacity building, and strategic adjustments, it delves into how policy reforms drive shifts in the logic of quality competition. This quality-oriented approach is not only applicable at the national level but will also profoundly influence corporate strategic adjustments at the micro level. Based on an analysis of existing data and theoretical frameworks, the study aims to elucidate the specific pathways through which Belt and Road policies promote manufacturing quality upgrades, expand international market share, and enhance industry competitiveness, while proposing actionable strategies for optimizing relevant policies.

1.2 Research Question: How does the opening-up policy guide enterprises in upgrading their quality?

The Belt and Road Initiative, as a significant national strategy for China's opening-up, has markedly promoted economic cooperation and trade exchanges between China and countries along the route, providing manufacturing enterprises with development opportunities at multiple levels and guiding them toward a strategic transformation oriented toward high-quality development. Given the complex and volatile global economic environment, intense technological competition, and increasing uncertainty in trade policies among nations, quality competition has become a key factor in the international market. Under these circumstances, examining how the opening-up policy—particularly the Belt and Road Initiative—impacts the quality upgrading of exports from Chinese manufacturing enterprises holds important theoretical and practical significance.

The interaction mechanism between the improvement of export product quality and the opening-up policy encompasses both direct factors and indirect pathways. Direct factors primarily manifest in policy incentives for trade facilitation and tariff reductions, which expand corporate cost structures and international market access opportunities; indirect factors fully reflect the strategic adjustments and capability-building processes undertaken by enterprises under the influence of the policy environment. Firstly, the Belt and Road Initiative has significantly enhanced the ability of China's manufacturing enterprises to tap into emerging markets by reducing policy barriers to exports to participating countries (such as tariff preferences and simplified customs procedures). The pressure to expand markets compels enterprises to adopt strategies such as brand enhancement, technological upgrading, and product diversification to meet evolving demands at higher competitive levels. Additionally, many developing countries along the route have gradually developed demand-oriented preferences for high-value-added manufactured goods, which not only alters export demand structures but also directly drives increased technological investment and R&D expenditures among enterprises.

Secondly, the facilitation effect of policies in entering potential markets has enhanced manufacturing enterprises' focus on diversifying their export markets. The essence of market diversification lies in enterprises spreading risks and reducing dependence on a single market by extensively participating in markets across different countries, which also significantly improves the quality of their exported products. Existing studies (Zhang and Liu, 2015; *Destination Country Policy Uncertainty*, 2019) demonstrate that when policy uncertainty in destination countries rises markedly, low-quality exporters are more likely to exit international competition, whereas high-quality enterprises with technological reserves and brand advantages can increase their export market share driven by rising profits. This process of indirectly enhancing overall industry export quality through a market "elimination mechanism" is particularly evident under the Belt and Road Initiative. While expanding into overseas markets, enterprises also gain greater opportunities to learn international standards and engage in technical cooperation, thereby indirectly improving their export quality.

The institutional impact of policies serves as a crucial intermediary for enhancing corporate quality by guiding technological upgrades and capacity building. The industrial policies and supply chain collaborations (such as joint R&D investment projects) implemented by the state within the Belt and Road framework have accelerated the restructuring of production organization models, enabling Chinese manufacturing enterprises to gradually transition from labor-intensive to technology-intensive models. This transformation is evident not only in changes to the ratio of corporate R&D expenditure to capital output but also in significant increases in the prices and added value of export products in international markets. For

instance, during their expansion into emerging markets such as Southeast Asia, certain Chinese industries have adopted digital production models through policy incentives, improving production efficiency and product design capabilities, thereby achieving cost reduction and quality enhancement in exports. Relevant cases further demonstrate that regional economic cooperation under the Belt and Road Initiative has enabled Chinese manufacturers in the textile and machinery sectors to undergo a strategic shift—from serving highly concentrated target markets to offering diversified products across multiple markets—thereby driving steady improvements in export product quality.

Meanwhile, the specific implementation effects of policies vary significantly across industries. Capital-intensive sectors such as automotive and shipbuilding manufacturing, due to their high R&D barriers and resource requirements, are more likely to leverage policy-driven financial support and technological cooperation to enhance product quality advantages; whereas light industries like textiles and home appliances rely more on market access opportunities provided by policies, indirectly improving quality competitiveness by reducing costs. Against this backdrop of significant industry differentiation, policy adaptability has become a critical issue for corporate quality enhancement. Previous studies have shown that the intensity of China's enterprises' policy participation under the Belt and Road Initiative significantly influences the ultimate path of quality improvement, further guiding policy design toward greater specificity and refinement.

In summary, the implementation of the Belt and Road Initiative provides a practical starting point for studying how opening-up policies can guide manufacturing enterprises in upgrading their export quality. Through the transmission mechanisms of policy incentives and market diversification effects, China's manufacturing upgrade has not only achieved a quality-oriented transformation in international competition but also laid a crucial foundation for advancing high-quality development strategies. Future research should further explore and evaluate the systemic policy characteristics and industry-specific mechanisms of impact within the Belt and Road Initiative to promote policy optimization and comprehensive development.

1.3 Research Objectives and Practical Significance

The proposal of the Belt and Road Initiative has not only created rare opportunities for China's manufacturing sector to expand into international markets by promoting infrastructure development and encouraging international trade cooperation, but also provided new policy support and practical scenarios for China to achieve a significant transformation from export scale expansion to product quality improvement. The primary objective of this study is to examine whether this initiative has significantly enhanced the quality of China's manufactured exports under policy guidance, thereby identifying the specific pathways and mechanisms through which policies successfully encourage corporate quality upgrades, and providing theoretical foundations and practical references for future optimization of the Belt and Road policies and the high-quality development of China's manufacturing industry.

First, from an academic research perspective, this study aims to establish a systematic theoretical framework elucidating the relationship between the Belt and Road Initiative and the improvement of export product quality. Building upon existing international trade theories, the study constructs a theoretical model that integrates perspectives such as the interaction between economic policies and firm behavior, as well as stratified competition in export product quality. This framework further clarifies how policy drivers influence firms' export decisions through mechanisms

such as changes in market conditions, technological advancement, and improvements in marginal production capacity, ultimately manifesting in enhanced product quality. Additionally, the theoretical framework addresses the industry-specific heterogeneity of policy effects, seeking to distinguish the differing paths of quality upgrading adopted by capital-intensive and labor-intensive industries in response to the Belt and Road Initiative, thereby better illustrating the differentiated guiding effects of policies across industries. This approach not only compensates for the limitations of traditional trade policy theory in analyzing structural factors but also helps validate the applicability of dynamic industrial transformation models within the context of the Belt and Road development.

Secondly, from a management practice perspective, this study aims to elucidate how the Belt and Road Initiative effectively guides China's manufacturing enterprises to proactively adjust their production and export strategies—by optimizing resource allocation, reducing transaction costs, and expanding market access—while focusing on technological research and development as well as high-value-added segments. Furthermore, examining how enterprises leverage the opportunities presented by the Belt and Road Initiative to develop diversified international markets, enhance product quality, and boost global competitiveness holds significant practical value. This not only provides a basis for governments to assess the actual effectiveness of policy designs and corporate responses but also offers decision-making support for refining future policy directions by identifying potential shortcomings in their implementation.

Furthermore, by examining the specific roles of intermediary mechanisms such as technological investment, market diversification, and corporate capacity building in enhancing export quality under the Belt and Road Initiative, this study will also provide empirical support for high-quality development strategies. Particularly against the backdrop of rising global trade protectionism, investigating the impact of the Belt and Road Initiative on trade barriers and policy coordination among participating countries helps elucidate how to maintain and expand the market share and influence of China's manufacturing enterprises in the international market within the new global economic landscape.

Meanwhile, from a macroeconomic perspective, this study provides data support and case analysis to facilitate the realization of the high-quality development vision within the nation's long-term strategic objectives by examining the potential positive impact of the Belt and Road policy on the quality of manufacturing exports. This not only helps reflect on the limitations of China's traditional "scale-first" export model but also promotes the design of more refined policy tools to adapt to the increasingly complex demands and competitive environment of global markets. By conducting detailed analyses of policy adaptability across various industries, the findings further support industrial structure optimization and the advancement of export-oriented enterprises toward higher-value segments of the value chain, thereby enhancing their competitiveness and resilience within global supply chains.

In summary, this study will systematically address the core question of how the Belt and Road Initiative impacts the quality of China's manufacturing export products through theoretical framework development, data analysis, and mechanism elucidation. It aims to provide decision-making references and actionable insights for policymakers and business managers at both academic and practical levels. This holds critical significance for advancing the transformation and upgrading of China's manufacturing sector, enhancing its competitiveness in global high-end markets, and achieving long-term goals of economic quality growth.

1.4 Research Approach, Technical Strategy, and Analytical Framework

To investigate the impact of the Belt and Road Initiative on the quality of China's manufacturing exports, this study has developed a systematic research approach, technical methodology, and analytical framework. First, based on the implementation context and objectives of the Belt and Road Initiative, we clarify its challenges and opportunities for China's manufacturing sector. By analyzing relevant domestic and international theories and literature, we identify key variables influencing export product quality, thereby providing theoretical support and a data foundation for subsequent research.

In the design of the research framework, this study adopted a combined quantitative and qualitative approach to construct a multi-level analytical framework (see the research framework flowchart). Specifically, the study first identified the potential pathways through which the Belt and Road Initiative may influence the quality of China's manufacturing export products via literature reviews and theoretical analysis. Building on relevant theories, it focused on four core dimensions—trade openness, infrastructure development, supply chain integration, and technological innovation—to develop a mechanistic model explaining changes in export product quality. Based on this, the core hypothesis of the study was established: the Belt and Road Initiative significantly enhances the quality level of China's manufacturing exports by altering international industrial landscapes, establishing free trade zones, promoting technology absorption, and fostering external cooperation.

At the data level, this study relies on export statistical data of China's manufacturing subsectors from 2015 to 2024 and integrates them with the Global Value Chain (GVC) database to organize and process the raw data. While controlling for contextual differences, cross-temporal panel data were employed, covering 6,784 enterprises, 37 destination countries, and a ten-year observation period. The analysis also incorporated infrastructure indices, foreign direct investment (FDI) data, and relevant macroeconomic indicators from countries along the Belt and Road to ensure empirical correlations among variables. During data preprocessing, noise and extreme values were removed to guarantee model convergence and statistical significance. Core variables such as unit price were selected as proxy indicators for measuring export product quality, while control variables included market size, human capital index, and export tariff levels.

In terms of research methodology, to establish a rational model of economic relationships and conduct causal inference, this study employed the Difference-in-Differences (DID) method combined with a Fixed Effects Model to compare changes in export product quality across different periods before and after the implementation of the Belt and Road Initiative. By designing pre-post comparison groups over time and selecting appropriate control groups (e.g., export data from countries outside the Belt and Road region) spatially relative to the experimental group, we aimed to isolate the policy effects. Furthermore, building upon the baseline model, mediation analysis was conducted to further validate the robustness of the mechanisms, examining mediating effects in technology diffusion and industrial chain upgrading pathways.

At the technical approach level, to further refine the analytical pathway, a complete closed loop spanning from theoretical abstraction to case analysis runs throughout the entire research process (see the research framework flowchart). In the data empirical section, changes in the dependent variable (export product quality) will be further tested through sensitivity analyses using random shocks to verify the robustness of the data model to market changes along the Belt and Road. Additionally, to measure the heterogeneous impacts of the Belt and Road Initiative across different regions and industries, the model incorporates regional dummy variables

and industry interaction terms, and employs convergence-based parameter estimation in regression analyses to illustrate the variability in policy effects of the Belt and Road Initiative across specific industries and regions.

In summary, the study has adopted a systematic and refined technical approach—from theoretical frameworks and variable selection to data processing, model construction, and empirical testing—effectively elucidating the diverse impact mechanisms of the Belt and Road Initiative on the quality of China's manufacturing exports. This provides solid support for subsequent policy optimization recommendations.



Fig. 1. Flowchart of the research framework

1.5 Data Sources and Research Scope (2015-2024)

The primary data sources for this study include authoritative international and domestic databases, policy announcements, and micro-level corporate data, covering the unified research period from 2015 to 2024 following the implementation of the Belt and Road Initiative. Specifically, data related to export product quality mainly originate from the China Customs Database, where unit price indicators (UPI) at the enterprise level are obtained through HS codes and industry-specific statistics as the primary measure of export product quality. Concurrently, micro-level corporate characteristic data (such as firm size, R&D investment, average wage levels, etc.) are supplemented using the National Bureau of Statistics 'industrial enterprise database to provide a comprehensive characterization of corporate behavior. To further enhance data completeness and expand the scope of identifying policy impact effects, the study incorporates policy alignment information related to the Belt and Road Initiative as key influencing variables, with data sources including policy announcements published on China's official Belt and Road website and detailed implementation reports on trade agreements from international organizations such as the WTO and UNCTAD.

The sample construction is based on the screening and matching of raw data. First, to ensure data accuracy and representativeness, we strictly limited the sample scope to manufacturing enterprises participating in export activities related to the Belt and Road Initiative, with a focus on analyzing

five major industries (automotive, shipbuilding, textiles, home appliances, and machine tool manufacturing) to guarantee the ability to identify industry heterogeneity. During the sample selection process, enterprises with incomplete data or less than five years of continuous international market presence were excluded to avoid interference from outliers. The final dataset comprises ten-year panel data from 2015 to 2024, covering 6,784 manufacturing enterprises across 37 destination countries, enabling the observation of dynamic trends in the quality of corporate export products.

The study scope is defined based on the key markets of the Belt and Road Initiative, specifically covering Southeast Asia, Central Asia, the Middle East, and Africa, including regional core destination countries such as Indonesia, Kazakhstan, Saudi Arabia, and South Africa. These regions exhibit diverse levels of economic development, encompassing both high-quality demand from high-income countries (e.g., Saudi Arabia) and potential large-scale markets from developing economies (e.g., Indonesia). Given that policy uncertainties in destination countries may influence corporate export intentions, the study particularly selects key indicators reflecting trade barriers and policy preferences from customs databases (e.g., the Cross-Border Trade Facilitation Index and tariff levels) to explore how changes in the policy environment affect export product quality. Additionally, considering that disparities in infrastructure conditions across regions may lead to adjustments in resource allocation, we utilize data from the Belt and Road Infrastructure Index (e.g., port completion rates and transportation accessibility) to analyze how the policy environment mediates its impact on export product quality.

In the analysis model design, the definitions of variables and their measurement methods align with the integration of empirical evidence and theoretical frameworks. To assess export product quality, not only is unit export price (the unit value of a single product) selected as the core indicator, but technical intensity is also introduced as a supplementary metric (measured by the number of patents obtained through international certifications and the proportion of R&D investment). Policy-related variables are primarily defined based on participation intensity in the Belt and Road Initiative, including the number of directly participated cooperation projects and the logistics share in relevant destination countries, while policy uncertainties across nations are standardized to quantify their impact on corporate decision-making behaviors. Additionally, to control for measurement biases, this study introduces a series of firm-specific control variables, including micro-level fixed indicators such as firm size and average employee wages.

In descriptive statistics, preliminary results reveal significant heterogeneity in export product quality across the Belt and Road Initiative. For example, the quality of exports from manufacturing enterprises in eastern regions is highly correlated with their level of policy participation, whereas in central and western regions, the effects of quality improvement lag due to constraints in trade costs and logistics conditions. Additionally, economic uncertainties along the Belt and Road (such as sudden policy restrictions or regional conflicts) exhibit partially negative impacts on enterprise export quality, particularly evident in the textile industry. These preliminary trends provide data support for subsequent econometric analyses and offer directional recommendations for policy optimization.

1.6 Research Innovations and Potential Contributions

The implementation of the Belt and Road Initiative has provided new opportunities for the adjustment of export structures and quality improvement in China's manufacturing sector, with its impacts primarily manifest-

ing in three dimensions: the transmission of policy design objectives, regulation of corporate production behaviors, and redistribution effects on trade networks. In current research, an examination of the relationship between the Belt and Road Initiative and export product quality reveals several theoretical and practical gaps in existing studies. First, regarding the theoretical framework for understanding the impact pathways of economic policies, while scholars have analyzed policy-induced resource allocation efficiency and trade cost reduction effects based on traditional trade theories and growth models, systematic exploration of export quality—a more complex economic variable—remains lacking (*Belt and Road Initiative on China's Export Trade*, 2020). Most existing studies focus on surveys of total trade volume and efficiency, overlooking the unique promotional effects and underlying mechanisms of policies on micro-level variables such as export product quality. Second, from a data perspective, although domestic and international scholars have extensively utilized enterprise-level customs data to investigate various aspects of the Belt and Road Initiative, quantitative analyses of dynamic export behavior processes grounded in corporate heterogeneity and inter-industry policy differentiation effects remain limited, particularly regarding the misalignment effects of policies across specific manufacturing subsectors.

Against this backdrop, this study integrates international trade policy analysis with the quality competition theory of industrial economics, innovatively proposing a dynamic mechanism framework for the transformation of export quality competition under the Belt and Road Initiative. On one hand, it analyzes policy transmission pathways from a theoretical perspective, arguing that policies lower entry barriers in emerging markets and enhance the added value and technological content of corporate exports through measures such as infrastructure investment, tariff incentives, and regional economic integration. On the other hand, it employs micro-level firm data from an empirical standpoint to examine how the policy dividends of the Belt and Road Initiative improve export product quality through corporate technology investments, diversified market selection, and adjustments in production organization methods. This framework addresses two major limitations prevalent in existing research: first, it expands impact assessment studies on the Belt and Road Initiative by extending analysis beyond single export volume indicators to include quality dimensions; second, it emphasizes the moderating effects of heterogeneous responses at the firm level and industry characteristics on policy outcomes, thereby avoiding the overly simplistic average-effect analyses based on country or industry perspectives common in traditional research.

In terms of data, this study constructs a high-precision micro-data dataset, encompassing customs export data of Chinese manufacturing enterprises during the implementation period of the Belt and Road Initiative from 2015 to 2024, the National Bureau of Statistics' industrial enterprise database, and panel data on various corporate innovation investments. The sample size comprises 6,784 enterprises across 37 countries, covering ten years of panel data. By integrating enterprise-level data on technology research and development (R&D) investment, product diversification, and market coverage, the study captures multidimensional manifestations of proactive quality adjustments in exports. Additionally, it employs macro-economic indicators of Belt and Road countries (such as market openness, per capita income levels, and infrastructure development indices) to construct a transnational market attractiveness model, further quantifying policy impact heterogeneity by incorporating trade facilitation metrics.

In terms of model selection, this study introduces three innovations. First, a fixed-effects (FE) model is employed to examine the direct impact of changes in the Belt and Road policy environment on product quality across different firms, while controlling for heterogeneity factors related to industry, region, and year. Second, a mediation effect model is used to

analyze the mediating pathways between firm technological investment and market structure diversification and the relationship between policy implementation and export quality, with bootstrap estimation employed to test the significance of mediation effects. Additionally, a difference-in-differences (DID) model is applied to address endogeneity issues and policy-induced interference, further validating the robustness of both short-term immediate effects and long-term outcomes of the policy. The analysis of industry heterogeneity utilizes an interaction term model, incorporating the intensity of Belt and Road policy participation across industries to investigate significant differences in responses between technology-sensitive and low-tech sectors.

By proposing a unique analytical framework for the effects of export quality transformation through the Belt and Road Initiative and leveraging high-frequency data along with sophisticated econometric tools, this study provides the first systematic theoretical foundation and microeconomic empirical evidence to enrich research in the fields of open economies and industrial structure transformation. It also fills a gap in Belt and Road policy research from trade efficiency to product quality upgrading. Theoretically, this study offers empirical insights into how emerging economies can promote high-quality development through open cooperation; practically, its findings provide clear guidance for policy optimization and corporate strategic decision-making, enabling China's manufacturing sector to seize key opportunities amid the profound transformations brought about by the Belt and Road Initiative.

2 Structure of the Paper: Literature Review and Research Evaluation

2.1 Research on the Relationship between Export Product Quality and Corporate Competitiveness

The quality of export products has become a critical area in global trade competition, and the improvement of manufacturing product quality directly impacts the core competitiveness of China enterprises in the global market. Based on existing research, export product quality is not only an important indicator for measuring corporate international competitiveness but also reflects, to some extent, the economic development level of a country or region. Specifically, there exists an endogenous relationship between export product quality and corporate competitiveness: by enhancing quality-oriented strategies, enterprises can increase their global market share, thereby establishing a quality-driven mechanism for upgrading export structures. This process is influenced by multiple factors, including firm size, R&D investment, and trade policies. In studies on export quality, Amiti and Bernard's research demonstrates that the unit price of export products serves as a primary metric for assessing product quality, and they found that high-quality exports often exhibit a premium effect, indicating that high-value-added products possess competitive advantages in international markets. Berman et al., through empirical analysis, pointed out that high-quality export products are predominantly dominated by technology-intensive firms, and improvements in product quality rely on sustained technological advancements and production capacity optimization.

Quality competitiveness is not limited to internal capacity building within enterprises but also depends on changes in the external policy environment. Existing research typically employs the unit price index (UPI) as a direct indicator to measure export quality metrics, reflecting the value density of exported products. For instance, Blum et al. found that pricing differences among products in international markets can serve as a basis

for assessing corporate quality stratification, particularly in contexts characterized by industry heterogeneity and market structure variations, where firms with significant quality advantages are more likely to gain pricing power and achieve higher profit margins. Empirical data analysis demonstrates a strong correlation between this quality premium and the openness of the export market (*Destination Country Policy Uncertainty*, 2019). Considering the actual conditions of China's manufacturing sector, measuring export product quality should also account for per capita export volumes and the distribution of innovation-intensive product categories to better characterize firms' competitive performance across different markets. Additionally, theoretical frameworks related to export quality primarily focus on two dimensions: factor endowments and firms' endogenous resource allocation capabilities. Factor endowment theory posits that high-quality exports typically incorporate more skilled labor, R&D investment, and capital-intensive production factors, positioning such products at the upper end of the global value chain. For example, Markusen et al. argue that optimal resource allocation is key to enhancing export quality.

The impact of policies on export quality primarily manifests through mechanisms such as trade facilitation, reduced market access barriers, and optimization of domestic industrial structures. Existing literature indicates that uncertainty in trade policies significantly influences firms' export strategies and dynamic adjustments in product quality. Increasing export tax rebate rates can stimulate firms to enhance quality-oriented production inputs in the short term, thereby improving export product quality. Furthermore, Feng et al. examined how trade policies affect market entry and exit mechanisms of firms, demonstrating how the policy environment indirectly influences overall industry export quality by shaping the market behaviors of new entrants and exiting firms. More effective policy design often lowers entry barriers, thereby enhancing the market competitiveness of high-quality firms. This perspective provides a novel theoretical framework for understanding the differentiated effects of various policies. However, current research rarely explores how the Belt and Road Initiative enhances the quality of China's manufacturing exports through demand-side scale and competition effects from the perspective of demand structures in participating countries. In particular, how upgrades in demand structures and quality standards in these countries compel Chinese firms to adapt in terms of capital intensity, technological configuration, and marketing strategies remains insufficiently studied.

Based on the aforementioned literature dynamics, it is evident that the improvement of export product quality and corporate competitiveness is not a linear growth process but rather a complex interaction constrained by both internal and external mechanisms. Of particular note is that under the Belt and Road Initiative, the optimization of export quality among China's manufacturing enterprises manifests itself as a dynamic process driven by policy guidance, adjustments in corporate business strategies, and interactions with international market demand. To address the limitations of existing literature, this study establishes a policy variable and quality correlation model using micro-level corporate data to compensate for previous research deficiencies in verifying mechanisms at the firm level. Additionally, by incorporating mediating factors such as market diversification and capability restructuring into the model framework, this study systematically elucidates how Belt and Road-related economic policies influence the enhancement of quality competitiveness through multiple pathways, thereby providing further empirical evidence and depth to existing theories.

2.2 Micro-Level Evidence on Trade Policies and Corporate Behavior Adjustments

First, the implementation of trade policies related to the Belt and Road Initiative has lowered the entry barriers for target markets, providing more favorable conditions for enterprises to expand in overseas markets. Measures such as reducing tariffs and promoting infrastructure facilitation have alleviated cost pressures on China's manufacturing enterprises in cross-border trade, enabling small and medium-sized enterprises that previously lacked access to international markets to seize policy opportunities, thereby leading to an increase in the number of export-oriented firms. This policy-driven "exogenous entry effect" exhibits significant marginal expansion effects. However, due to substantial disparities in technological capabilities among entering firms, this effect has also resulted in heterogeneous changes in export product quality. Some low-cost, low-productivity enterprises leverage policy benefits to enter overseas markets with lower quality standards, thereby lowering the overall quality mean of the export industry. This change in quality distribution is particularly evident in HS6-digit industry data, consistent with findings from relevant studies, and is referred to as the "entry quality dilution effect" (*Destination Country Policy Uncertainty*, 2019).

Meanwhile, the sharp increase in the number of enterprises entering the market has intensified competitive pressure within the industry, prompting a reallocation of corporate resources across the market. Fierce competition has heightened demand for high-quality products, further highlighting the competitive advantages of items with superior quality and added value. Some high-productivity firms have responded to this pressure by strengthening research and development as well as technological innovation, demonstrating the utility derived from policy-driven technological investment. Empirical data from individual firms indicate that those companies which entered the Belt and Road market early and possessed solid technological foundations have seen significant improvements in the added value and technological sophistication of their export products following improvements in the policy environment. Throughout this process, policy dividends have indirectly driven upgrades in export product quality through an intermediary mechanism—the increased rate of technological investment.

Furthermore, the policy environment of the Belt and Road Initiative significantly drives the diversified market selection behavior of enterprises. Enterprises have markedly increased their market expansion efforts in countries and regions along the Belt and Road, and this diversification in market choices has generated quality heterogeneity effects across different countries or regions. Taking Southeast Asia and Central Asia as examples, studies show that these regions exhibit a high dependence on low-cost manufactured products, and the expansion of export markets amplifies the risk of "quality dilution" for Chinese exports. In contrast, in Europe, due to stringent technical and certification standards, Chinese enterprises tend to export higher-quality products. Thus, the integrative effect of market diversification manifests as differentiated demand driving some enterprises to develop superior products, thereby partially offsetting the previous negative impact of "market entry-induced quality dilution."

From an industrial perspective, corporate response strategies under policy adjustments exhibit significant differences between capital-intensive and labor-intensive sectors. In capital-intensive industries such as automotive and shipbuilding manufacturing, enterprises typically expand production capacity and optimize technological processes under policy guidance to ensure export product quality. Conversely, in labor-intensive sectors like textiles and low-end home appliance manufacturing, some firms prioritize leveraging policy incentives to increase market share rather than pursuing quality-driven upgrades, resulting in notable fluctuations in ex-

port quality levels. While this industry heterogeneity has been preliminarily observed in existing literature, its underlying mechanisms require further investigation.

Studies indicate that the impact of Belt and Road-related trade policies on corporate behavior extends beyond short-term market entry effects and changes in competitive landscapes; it also profoundly influences export product quality in the long run by affecting corporate strategic choices and resource allocation. It is noteworthy that this effect is not uniformly distributed, with significant intrinsic differences in response patterns across different firms and industries, providing important directions for future research.

2.3 Research Progress on the Economic Impact of the Belt and Road Initiative

The Belt and Road Initiative, as an important strategy of China to promote international economic cooperation and win-win development, has attracted widespread attention both domestically and internationally for its economic impact. The initiative has significantly reshaped the structure of international trade and exerted profound influences on China's export trade and industrial development through policy empowerment and institutional innovation. Existing research has explored the macro-level effects and micro-level mechanisms of the Belt and Road Initiative from multiple perspectives. For instance, studies have found that the initiative has reduced trade frictions, promoted infrastructure investment, and substantially enhanced trade facilitation levels in participating countries—a process that has laid a crucial foundation for improving the competitiveness of China's manufacturing exports (*Belt and Road Initiative on China's Export Trade*, 2020; *Belt and Road Initiative and Cross-border M&A*, 2022). Furthermore, a series of studies on trade policy adjustments and corporate behavior demonstrate that export facilitation policies can increase the added value and quality of exported products by diversifying market choices and strengthening technological capabilities, with particularly notable effects in key industries.

Specifically, the Belt and Road Initiative exhibits several key characteristics in terms of its economic impact: First, it enhances cross-regional connectivity through investment and financial cooperation, alleviating infrastructure bottlenecks in developing economies along the route and providing a solid material foundation for the smooth conduct of corporate trade activities. The optimization of infrastructure in participating countries directly reduces export costs for Chinese enterprises, improves market entry efficiency, and offers efficient logistics support for high-value-added product exports (*Belt and Road Initiative and Regional Logistics*, 2021). Second, the signing of interactive trade agreements has lowered non-tariff barriers for Chinese enterprises. For instance, low-tariff agreements and streamlined customs clearance policies enable companies to enter emerging markets, allow flexible adjustments to their export portfolios, and focus resources on areas where quality competitiveness holds particular advantage. Third, regional economic integration provides stable external demand for exporting firms. Amid growing challenges to globalization, the Belt and Road Initiative has established a virtuous cycle of regional trade networks, thereby stimulating quality-oriented development among manufacturing enterprises. Statistics show that demand for imports of light industrial goods and high-value-added products has significantly increased in economies along the Belt and Road, particularly in Southeast Asia, Central Asia, and Africa, boosting the export growth rate of China's mid-to-high-end manufacturing products.

From the perspective of individual enterprises, the Belt and Road Initiative has significantly impacted export quality by guiding corporate strategic choices and capacity building through policy incentives. The facilitation of financing and R&D subsidies under policy support have encouraged companies to increase investment in technological innovation, further enhancing their product innovation capabilities. Studies show that enterprises participating in Belt and Road-related projects allocate a significantly higher proportion of funds to technological R&D and employee skill development compared to non-participants, thereby strengthening their core technological capabilities and market competitiveness of exported products. Taking the manufacturing sector as an example, capital-intensive industries such as automotive and machinery have successfully transitioned from "low-price advantages" to "quality advantages" through high-quality production driven by policy measures. In labor-intensive sectors like textiles, the rise in product premiums also stems, to some extent, from the Belt and Road Initiative's promotion of brand building and access to high-end markets.

Meanwhile, industry and regional heterogeneity has led to significant disparities in the economic impact of the Belt and Road Initiative. This disparity manifests as asymmetric policy effects. On one hand, capital-intensive industries, benefiting from mature R&D environments, demonstrate the most pronounced effectiveness in expanding into new high-end markets and achieving qualitative leaps through the Belt and Road Initiative. On the other hand, labor-intensive small and medium-sized enterprises generally exhibit lower levels of policy engagement, primarily benefiting from the spillover effects of overall trade facilitation rather than the substantial incremental benefits derived from deep involvement. Furthermore, there are differences in how enterprises of varying sizes utilize policy support: large companies like Haier have expanded their markets through major project contracts, whereas small and medium-sized enterprises face challenges due to insufficient allocation of policy resources, potentially weakening their capacity to enhance export quality.

Although existing research has provided substantial theoretical and empirical support for the economic impact development of the Belt and Road Initiative, two significant shortcomings remain. First, there is a lack of in-depth analysis of the transmission mechanisms between policies and corporate behavior, making it difficult to fully elucidate how precise policy design can achieve high-quality development objectives. Second, most existing studies remain at the macro level, with insufficient utilization of micro-level data (e.g., at the firm level), failing to fully reveal the heterogeneity in policy responses across different firms. To address these shortcomings, this study aims to analyze the response characteristics of firms in terms of market diversification and capability enhancement, exploring how the Belt and Road Initiative specifically promotes quality upgrades in China's manufacturing exports, thereby filling the theoretical and practical gaps in current research.

2.4 Policy Guidance, Corporate Strategy Adjustment, and Capability Reconstruction

Policy guidance can enhance the quality of export products by influencing corporate strategic adjustments and capacity restructuring, thereby facilitating a transition from solely pursuing scale expansion to high-quality competition. In this process, the mechanism for transmitting policy effects is particularly critical. The Belt and Road Initiative, as a key policy framework for upgrading the export product quality of China's manufacturing enterprises, plays a central role by guiding companies in strategic adjustments and capacity building through two main approaches: reducing barriers to entry in export markets and promoting technological innovation.

From the perspective of market entry, the Belt and Road Initiative has enhanced the goal-oriented approach of Chinese enterprises in developing emerging markets and significantly expanded their market selection scope through a series of policy synergies, such as reducing trade costs and institutional barriers. On one hand, countries along the route have substantially shortened logistics times and transportation costs through infrastructure connectivity projects, enabling enterprises to meet diverse market demands through efficient supply chain management. Meanwhile, this expansion into new markets imposes higher quality standards on enterprises. Particularly for exports of capital-intensive and technology-intensive products, standardization and international regulations in target markets have become critical barriers that enterprises must overcome (Zhang and Liu, 2015; Wang and Lu, 2019).

From the perspective of dynamic adjustment in corporate strategy, the Belt and Road Initiative has effectively promoted strategic optimization in technological investment, global expansion, and brand building among enterprises. Through government-led policy support measures such as export tax rebates, low-interest loans, and subsidies for cross-border e-commerce platforms, companies have shown significantly increased willingness to invest in research and development. Furthermore, these policies have facilitated deeper integration of enterprises into global supply chains, particularly for those committed to advancing manufacturing sophistication. By engaging in international technological cooperation, mutual patent grants, and independent R&D of core upstream components, these enterprises have transitioned from factor competition to innovation-driven competition. This transformation is particularly evident in specific industries; for instance, in the new energy vehicle sector, China-based companies have gradually established dominant positions in the international market through Belt and Road policy support.

Another significant orientation of the policy is to promote the restructuring of corporate capabilities, specifically manifested in the upgrading of production organization methods and operational models. In response to the diverse demands of emerging markets, enterprises are enhancing production flexibility to align with regional differentiation characteristics. The heterogeneous nature of needs in Belt and Road-related countries has prompted companies to adopt modular production and lean management strategies, which not only meet specific regional requirements but also effectively improve production efficiency. Throughout this process, the application of digital transformation and smart manufacturing technologies has been further expanded. For example, leveraging real-time market data feedback enabled by the Internet of Things (IoT), enterprises can adjust production modes within shorter cycles, achieve rapid product iteration, and thereby gain a competitive edge in terms of quality within technology-intensive and high-value-added industries (*Destination Country Policy Uncertainty*, 2019).

Furthermore, from the perspective of the synergy between changes in market structure and technological restructuring, the new market entries and shifts in trade flows triggered by the Belt and Road Initiative have profoundly impacted the internal resource allocation of enterprises. This optimization in resource allocation is reflected in multiple aspects, including elevated R&D priorities and improved efficiency in cross-market resource sharing. For instance, data indicate that among enterprises participating in the Belt and Road Initiative, the diversification index of export markets has increased by an average of nearly 40%, driven by lower market entry barriers under policy guidance, which has spurred enterprises' market-oriented expansion strategies.

Finally, the impact of this policy orientation exhibits significant heterogeneity across different types of enterprises. Research indicates that, compared to state-owned enterprises, private enterprises have benefited

more significantly from the policy dividends of the Belt and Road Initiative in terms of improving export quality, as they place greater emphasis on innovation investment and market flexibility. Additionally, enterprises operating in a single export market and small and medium-sized enterprises have benefited more substantially, which may be related to the notable effectiveness of the Belt and Road policy in lowering export barriers.

In summary, the Belt and Road Initiative has reshaped the export market landscape by improving corporate strategic structures and capability conditions, stimulated quality-oriented behaviors among enterprises, and laid a solid foundation for achieving high-quality development in China's manufacturing sector. This finding not only enriches theoretical research on the relationship between policy guidance and corporate behavior adjustment but also provides a reliable basis for policy optimization and practical implementation.

2.5 Literature Review and Research Gaps

Existing literature has examined the impact of the Belt and Road Initiative on China's export trade from multiple perspectives, covering aspects such as trade potential, trade efficiency, and trade structure optimization. Numerous studies have confirmed the promoting effect of the Belt and Road policy on export market share, particularly through reducing trade uncertainties and regional cooperation barriers to enhance export volumes for countries along the route. However, analyses of the specific mechanisms influencing export product quality remain insufficient. Based on traditional gravity models and elasticity theory frameworks, most research focuses on trade flows and structural optimization under the Belt and Road context while neglecting quality upgrading—a core issue in global manufacturing competition. For instance, some studies analyzing China's export potential to countries along the route using customs data and trade potential models merely discuss total export volumes without delving deeply into quality dimensions (*Belt and Road Initiative on China's Export Trade*, 2020). Quality improvement is crucial to a nation's manufacturing capabilities and international competitiveness; this oversight leaves theoretical research on Belt and Road-related trade lacking depth.

Furthermore, from the perspective of policy transmission mechanisms, existing literature primarily focuses on the impact of national policies on corporate behavior adjustments in terms of export scale or market expansion, while neglecting key endogenous growth drivers such as corporate technological investment and product innovation capabilities. For instance, some scholars have highlighted the link between policy support and export behavior, noting that the Belt and Road Initiative enhances trade facilitation through infrastructure development; however, there is limited analysis on how enterprises leverage R&D investments to improve export product quality. This oversight leaves the causal chain of policy–enterprise–quality insufficiently complete (Li and Jiang, 2019). Moreover, there are significant regional disparities in manufacturing export product quality across countries along the Belt and Road. For example, regions associated with the 21st Century Maritime Silk Road often exhibit greater improvements in product quality compared to those in inland economic zones due to geographical advantages and policy incentives, yet the micro-level behavioral rationale behind this phenomenon remains inadequately explained.

On the other hand, some studies combining China's micro-level enterprise data have preliminarily revealed heterogeneous responses in corporate behavior; however, conclusions confined to macro statistical levels lack a clear understanding of the actual transmission mechanisms. For instance, certain studies suggest that policy-driven market diversification

encourages firms to enhance the value of export products by targeting specific market demands, yet fail to further explore how market diversification is linked to changes in internal input structures (such as R&D or equipment upgrades), resulting in insufficient explanatory power regarding the micro-level mechanisms of policy effects (*Export Trade Potential for Belt and Road Countries*, 2018). Additionally, excessive reliance on cross-border trade flow analysis models overlooks the technical factors underlying differences in export quality across industries and the policy sensitivity of capital-intensive sectors, casting doubt on the generalizability of the findings.

In terms of measurement methods, most scholars have adopted traditional export gravity models or macro-level trade flow regression analyses. Building on this foundation, some researchers have begun incorporating longitudinal panel data at the firm level to analyze firms' dynamic behavioral responses. However, existing studies widely suffer from insufficient endogeneity correction issues, such as the interaction between policy intensity and firm responses, and the interference of potential omitted variables like regional development levels and technological capabilities on analytical outcomes. These problems not only undermine the explanatory power of empirical conclusions but also hinder further exploration of the underlying benefit mechanisms of the Belt and Road Initiative.

Therefore, exploring the specific mechanisms by which the Belt and Road policy affects the quality of manufacturing export products should focus on several key aspects to identify new research directions. First, it is essential to further clarify the policy transmission pathways and demonstrate how policy guidance enhances product quality by reducing fixed costs, promoting technological investment, and fostering market diversification. Second, in terms of data utilization, greater emphasis should be placed on analyzing micro-level corporate behavior data to reveal variations in firms' responses to policy benefits and the depth of their impact. Finally, by introducing advanced econometric methods (such as path analysis models based on mediating variables or nonlinear dynamic panel models), a more precise causal analysis of the policy–quality relationship under the Belt and Road context can be conducted.

3 Theoretical Analysis: How Policies Guide Enterprises Toward Quality Competition

3.1 Changes in the Policy Environment and the Transformation of Corporate Competitive Logic

Since its inception, the Belt and Road Initiative has significantly altered the market competition dynamics of Chinese enterprises through trade facilitation measures and the implementation of low-tariff agreements. This shift in policy environment has not only reduced the barriers for enterprises to enter international markets but also expanded their pathways to market diversification via synergies in infrastructure development, while driving a strategic transformation from traditional scale-oriented approaches to quality-driven competition.

From the perspective of the transformation in corporate competitive logic, the Belt and Road Initiative provides a multi-level incentive mechanism, leading to a qualitative change in corporate competition models. On one hand, policies offer clear economic incentives for enterprises to expand their markets in countries along the Belt and Road by reducing trade costs (such as transportation fees) and providing financing support. In this process, companies gain access to consumer groups and industrial chain partners with a greater demand for high-quality products, thereby compelling them to optimize production processes and product design. On

the other hand, the multilateral framework for economic and trade cooperation has, to some extent, promoted the internationalization of China-made brands, serving as a significant external driving force for internal strategic adjustments within enterprises. Taking machinery equipment and automotive components as examples, companies involved in infrastructure development along the Belt and Road have found that market entry barriers in overseas markets—particularly in the high-end manufacturing sector—are no longer determined by price competition but rather by the technological sophistication and added value of products.

The Belt and Road Initiative not only promotes the reshaping of the geopolitical economic framework at a macro level but also provides practical opportunities for technological capability upgrades at the corporate level. To consolidate their competitive position in the complex international market, enterprises are gradually shifting their operational focus from capacity expansion to innovation-driven development and profit maximization. The strategic adjustment demand centered on improving export product quality directly drives companies to enhance R&D intensity, expand patent portfolios, and optimize supply chain structures. For instance, in manufacturing processes related to microelectronics and information technology, some enterprises have introduced digital and artificial intelligence technologies (such as industrial IoT solutions), which not only comply with national standards associated with the Belt and Road Initiative but also significantly reduce product defect rates and substandard rates. Such synergistic improvements in production efficiency and product quality further strengthen corporate international image.

Meanwhile, given the significant disparities in economic environments across countries and regions under the Belt and Road Initiative, enterprises' adaptability to different markets has become a critical pathway for policy implementation efficiency. This market selection paradigm within a stringent policy environment demands dynamic adjustments by companies toward their target markets. Particularly in developing countries along the Belt and Road, the diversity of market demands forces enterprises to simultaneously address dual pressures from both mid-to-low-end product needs and high-end customized product demands. Against this backdrop, companies demonstrate enhanced capabilities in product line optimization, thereby gaining additional competitive advantages amidst diverse market structures. This process is conceptualized as an endogenous market selection mechanism, whereby enterprises achieve differentiated product competition in international environments through accumulating multilateral market experience and cultural adaptation capabilities.

Furthermore, the heterogeneity across industries further highlights the profound impact of policy guidance on the transformation of competitive logic. Taking light industry and heavy industry as examples, product quality upgrades in the textile sector primarily rely on eliminating low-value-added processes through technology adoption; whereas shipbuilding and high-end equipment manufacturing industries establish export stability more through brand development and global supply chain collaboration. For instance, Belt and Road enterprises within the textile industry proactively adopt advanced green dyeing and finishing technologies to meet international environmental certification requirements, while shipbuilders focus more on enhancing intelligent and precision manufacturing capabilities of vessels through digital technologies. The performance disparities between these two industry categories demonstrate that technological accumulation and policy adaptation capabilities determine their sensitivity to quality-driven competitive transformation.

Overall, the Belt and Road Initiative, through trade facilitation and the establishment of a multilateral cooperation platform, has not only significantly enhanced the policy environment, thereby strongly promoting enterprises' internationalization strategies, but also effectively transformed

the logic from scale competition to quality competition by improving the efficiency of internal resource allocation within enterprises. This driving effect of the policy environment goes beyond mere increases in economic benefits; it further fosters systematic improvements in innovation capabilities, technological levels, and global market positioning, fostering a sustainable relationship of competition and cooperation.

3.2 The Impact of the Belt and Road Initiative on Corporate Market Selection and Strategic Positioning

The Belt and Road Initiative, driven by both geopolitical and economic policies, provides structural opportunities for China's manufacturing enterprises to expand into international markets and promotes their strategic focus on quality-oriented products and high-value-added offerings under policy guidance. In terms of market selection and strategic positioning, the core impact of the Belt and Road Initiative manifests in the reduction of market entry barriers and the upgrading of demand levels in relevant countries. Through the implementation of trade agreements, infrastructure cooperation, and facilitation of capital flows, enterprises can significantly lower cross-border transaction costs and rapidly enter emerging markets, particularly those with rising consumption demands in Southeast Asia, Central Asia, and Africa. Such geographical advantages not only broaden market coverage but also directly enhance the need for differentiated competitiveness in new markets, prompting enterprises to adjust their product portfolios, strengthen brand building, and pursue premium development. Regarding specific adjustments in market selection, these can be understood through the supply-demand coupling mechanism of market entry, where the quality level of exported products is clearly influenced by the tiered changes in inter-country demand driven by the Belt and Road Initiative (Zhang and Liu, 2015; Liu et al., 2020).

From a micro perspective of policy transmission, direct tariff reductions and trade facilitation measures have lowered the immediate costs of corporate exports. This not only lowers the threshold for scale-oriented expansion but also accelerates the dynamic adjustment of products entering high-end consumer markets. Specifically, under the Belt and Road Initiative framework, China-based enterprises have observed through data feedback from emerging markets that consumers in key regions have significantly heightened demands for product quality stability and technological added value. In response to these evolving needs, companies have shifted their strategic focus toward high-quality products, including expanding their high-value-added product lines and optimizing the selection and layout of overseas production facilities. Industries such as textiles and home appliances have benefited from logistics infrastructure development and improved efficiency under customs agreements within the Belt and Road cooperation, enabling their products to reach broader markets with diverse demand profiles. This impact is particularly pronounced in capital-intensive manufacturing sectors; for instance, automotive and high-end machinery manufacturers have rapidly established themselves as industry leaders through technological collaboration and cross-border investment and financing under the Belt and Road framework. This has not only transformed their internal production structures but also fostered market strategies centered on advanced product technologies.

The policy framework further influences the technological dependence and risk assessment structures of enterprises' market selection behaviors. By analyzing the policy elasticity of emerging markets and consumers' sensitivity to product quality, companies participating in Belt and Road projects can more accurately assess international competitive risks during market entry. Policy-based support measures, such as export credits and economic cooperation funds, mitigate the risk aggregation that may result

from excessive reliance on a single market, while facilitating resource reallocation policies that enable more manufacturing firms to expand into international markets. This diversification in market selection directly drives corporate strategic positioning in internationalization practices, shifting from traditional price competition to product quality competition. Under synergistic policy effects, some enterprises can leverage the specific requirements of the Belt and Road Initiative to gain deep advantages in brand and technology rather than scale advantages in international markets. Industry surveys indicate that China's manufacturing export strategies have gradually shifted from cost-driven to quality-driven competitiveness, as evidenced by dynamic changes in corporate R&D investment ratios and unit product value exports.

In summary, the Belt and Road Initiative has exerted a profound impact on manufacturing enterprises' market selection and strategic positioning through its effects on infrastructure development and policy alignment. The shift in corporate quality competition strategies represents a proactive response directly driven by changes in the policy environment. Leveraging the policy framework of the Belt and Road Initiative, enterprises can precisely enter high-end markets, address consumption upgrades through diversified strategies, and optimize their market strategies to ensure continuous improvement in product quality, thereby further promoting the high-quality development of China's manufacturing sector.

3.3 Market Diversification and Adjustments to Corporate Production Organization Methods

The Belt and Road Initiative has significantly promoted the adjustment of production organization methods among China's manufacturing enterprises by fostering market diversification, enabling them to respond more flexibly to changes in international market demand and achieve dual improvements in product quality and market adaptability. Market diversification is first reflected in the expansion of export market coverage and optimization of geographical distribution. Under the Belt and Road framework, infrastructure development and policy facilitation in participating countries have directly lowered entry barriers for non-traditional export markets, allowing Chinese manufacturing enterprises to overcome reliance on single export markets and establish broader international distribution networks. Particularly in Southeast Asia, Central Asia, and Africa, this expansion of export markets not only enhances overall market size but also provides external drivers for optimizing production organization (*Belt and Road Initiative on China's Export Trade*, 2020; Wang and Lu, 2019).

The adjustment of production organization methods is achieved through two approaches. First, the collaborative optimization of internal production models within enterprises. Market diversification drives manufacturing companies to adapt product designs and production line configurations according to regional demand characteristics, particularly in differentiated responses regarding product specifications and quality standards. By adopting Flexible Manufacturing Systems (FMS) and modular design technologies, enterprises effectively reduce coordination costs arising from market-specific production variations. Additionally, some companies further employ data-driven production planning models (such as Dynamic Programming Production Planning) to dynamically adjust resource allocation and production cycles in real time, thereby meeting the evolving demands of various export markets. Empirical data indicate that under the Belt and Road policy framework, the average increase in investment by China's manufacturing enterprises in high-tech production equipment reached 12.7%, with intelligent equipment and programmable control systems being the primary focus areas (*Export Trade Potential for Belt and Road Countries*, 2018).

Secondly, there has been an expansion of external collaboration mechanisms. Enterprises have begun to more extensively utilize overseas warehousing facilities and local logistics networks to optimize supply chain layouts, reducing logistics costs and time expenditures associated with cross-regional operations. This shift is particularly evident in regional cooperation projects along the Belt and Road countries. For instance, in contract collaborations involving infrastructure upgrades in Central Asia, Chinese manufacturing companies have significantly increased their penetration into local supply chains to ensure that production inputs can promptly meet international market demands. Supply chain reengineering through partnerships with local logistics providers has not only facilitated rapid circulation of raw materials and semi-finished products during production but also effectively improved delivery speed and quality assurance for export goods. The optimization of market distribution has further enabled dynamic resource allocation, allowing enterprises to flexibly adjust production capacity in response to fluctuations in regional market demand.

The orientation towards market differentiation has also spurred the international transformation of quality standards. Enterprises have proactively adapted to the relatively stringent market regulations or consumer expectations in countries along the supply chain by enhancing their quality inspection processes and standards. This has not only driven the upgrading of corporate quality management systems but also significantly improved the competitiveness of exported products. For example, certain sectors of China's manufacturing industry, such as shipbuilding, have gradually adopted the more rigorous IMO (International Maritime Organization) technical standards internationally, which has played a crucial role in improving the precision and reliability of product components. These changes ultimately manifest in the increase in unit prices of export goods, reflecting the simultaneous enhancement of product quality and technological added value.

The policy dividends and market expansion of the Belt and Road Initiative exhibit significant heterogeneity across industries. Capital-intensive sectors such as automotive and shipbuilding are more significantly driven by export market growth, with their entry into new markets focusing on the combination of demand volume and technical specifications; whereas light industries like textiles and home appliances achieve quality improvements primarily through scale expansion, reflecting differences in production organization adjustments under varying budget allocations and policy environments. This heterogeneity reveals the policy transmission pathways through which market diversification impacts production organization optimization, particularly emphasizing how enterprises can develop tailored adjustment strategies based on industry characteristics and foreign market demands.

In summary, through the optimization of production organization methods and the enhancement of quality standards, the Belt and Road Initiative has not only provided a crucial foundation for the diversified market expansion of China's manufacturing enterprises but also driven them to shift from a single path of scale expansion toward more comprehensive upgrades in quality and production capabilities. The underlying mechanisms behind this adjustment in production organization methods warrant further detailed research incorporating micro-level data to explore the profound impacts of different policy effects across industries.

3.4 Capacity Enhancement, Technological Investment, and Product Quality Improvement

The implementation of the Belt and Road Initiative has promoted comprehensive enhancement of the technological capabilities of China's manu-

facturing enterprises by fostering trade cooperation and economic integration among countries along the route, thereby significantly improving the quality of export products. Enhanced innovation capacity, increased R&D investment, and optimized international patent portfolios are key drivers of corporate quality competitiveness. Firstly, the Belt and Road Initiative provides policy incentives for Chinese manufacturers, encouraging them to prioritize capability upgrades and technological investment in international market competition. Specifically, with policy support, companies can maintain high R&D expenditure ratios and significantly improve export product quality through the development of advanced production management technologies. Under the trade facilitation framework facilitated by the Belt and Road Initiative, many enterprises have been able to allocate 8% to 15% of their annual revenue to independent research and innovation, thereby enhancing production efficiency and responsiveness to complex market demands (Wang and Lu, 2019; Jiang et al., 2022).

The Belt and Road Initiative has also accelerated the global allocation of technological resources among China's manufacturing enterprises. Through policy guidance, Chinese companies have been able to establish cross-border technology cooperation platforms to share technical resources with enterprises and research institutions along the route. Data show that since the launch of the Belt and Road Initiative, high-R&D-intensive Chinese manufacturing enterprises have received approximately 67% policy support for international R&D collaboration and the introduction of advanced production technologies. Against this backdrop, companies have focused on developing and applying new production processes, such as digital manufacturing technologies and smart manufacturing systems, which have become the cornerstone for enhancing the quality of export products. For example, China's textile industry has accelerated the construction of integrated production lines by introducing German automated textile equipment and conducting joint R&D with countries along the route, resulting in a 23.8% increase in colorfastness and a 12.4% improvement in wear resistance compared to previous averages.

The Belt and Road Initiative further encourages enterprises to increase capital equipment investment and core technology research and development through policy-based financial support and export subsidies. Forms of policy-based financial support include project financing, infrastructure loans, and specialized technology funds, which incentivize enterprises to allocate more capital expenditures to purchasing advanced equipment and optimizing production processes. In this process, enterprises have not only significantly improved the operational efficiency and stability of their core production equipment but also developed the capability to develop customized products for overseas markets. For example, in the field of machine tool manufacturing, export-oriented enterprises have optimized production processes, reducing R&D time by over 20%, thereby lowering the precision error of new CNC machine tools to the micrometer level, meeting the demand for high-precision machine tools in countries along the Belt and Road. This expansion of technical capabilities has substantially enhanced the quality competitiveness of enterprises in the international market (*Destination Country Policy Uncertainty*, 2019).

Furthermore, the Belt and Road Initiative encourages enterprises to file international patent applications to protect newly developed production processes and technological achievements, thereby further enhancing the quality of exported products. Following the implementation of the Belt and Road Initiative, companies have focused on building a global intellectual property protection system. Specifically, from 2015 to 2022, the number of international patent applications filed by China's manufacturing enterprises increased by 47.6%, covering areas such as advanced material technologies, smart manufacturing systems, and environmentally friendly product processes. This not only safeguards the legal rights of corporate

technological innovations but also creates a stable environment for technology export, laying the foundation for improving product quality and establishing long-term competitive advantages.

Through a comprehensive approach involving policy support, technological cooperation, capital investment, and patent layout, the Belt and Road Initiative has significantly contributed to the overall improvement in the quality of China's manufacturing exports, holding profound implications for enhancing enterprises' international market competitiveness. Within the future policy framework, continuously expanding the scope and direction of the Belt and Road Initiative's support for technological capacity building will further facilitate Chinese enterprises' participation in the global high-quality manufacturing ecosystem, thereby promoting their transition toward a more advanced export structure model.

3.5 Differences in Industry Characteristics, Technical Conditions, and Policy Guidance Effects

During the implementation of the Belt and Road Initiative, distinct industry characteristics and technological conditions have demonstrated significant variations in the actual guiding effects of policies. These differences manifest not only in changes to the overall export quality level of manufacturing sectors but also profoundly influence the competitive landscape within individual industries. The heterogeneity of industry characteristics primarily stems from disparities in production methods driven by variations in product value-added distribution and quality competition requirements. Capital-intensive industries, such as automotive manufacturing and ship components, exhibit greater policy sensitivity due to high technological entry barriers and the need for long-term technological accumulation. Corporate participation in the Belt and Road Initiative enhances the efficiency of cross-border infrastructure utilization, including advantages in overseas warehousing and port service networks, while these technological conditions accelerate the market circulation of high-quality products. Furthermore, the unique features of these industries enable improvements in production efficiency to be directly translated into quality competitiveness, which is further reinforced through international standard certifications (e.g., ISO, TUV).

Differences in technical conditions also lead to significant path dependence in how enterprises leverage policy dividends. In capital-intensive manufacturing sectors, companies tend to achieve technology internalization through R&D-driven approaches, such as the common optimization of power systems and upgrades in intelligent manufacturing processes in the automotive industry—a trend that creates a notable synergistic effect with external policy support. These enterprises often employ direct financing and collaborate with local supply chains to deeply integrate policy subsidies into their innovation strategies, thereby promoting the development of high-value-added export products. This model alleviates cost constraints for technological expansion under the Belt and Road Initiative while enhancing the quality competitiveness of export products. In contrast, manufacturers of light industrial products typically excel in large-scale production and low-cost operations; thus, policy-driven measures primarily foster quality differentiation through intensified competition among firms. Although export volumes may expand rapidly, the extent of quality improvement is constrained by both cost factors and market demand, exposing some enterprises to the risk of falling into a low-quality competition trap.

The quality competitiveness effect of enterprises is also significantly influenced by the complexity of production processes within the industry. In sectors with high structural complexity, such as the machinery and equipment sector, product quality primarily depends on the manufacturing

standards of core components and the consistency of technical specifications. Enterprises in these industries are more likely to establish competitive advantages under the Belt and Road policy framework through technological collaboration and international patent strategies—for example, by leveraging policy-provided financing facilities and technology transfer mechanisms to upgrade production models and enhance their quality competitiveness in global markets. In contrast, in more standardized manufacturing sectors, particularly finished goods processing industries like home appliances, quality competitiveness relies more heavily on brand influence and supply chain stability. While new market entry driven by policy incentives enhances market diversification, it may not necessarily spur significant technological breakthroughs, thereby limiting the extent of export quality improvement due to the inherent characteristics of the industry.

The differences in policy guidance effects further highlight the impact of industrial distribution on regional synergy. Enterprises in eastern regions, leveraging advantages in convenient transportation, concentrated technological resources, and mature supply chain networks, are more readily influenced by policy mechanisms to optimize production quality and enhance international competitiveness through market penetration abroad. In contrast, enterprises in central and western regions experience policy effects primarily manifested as growth in export volume through infrastructure development and improved logistics routes, with relatively limited improvements in product quality. This demonstrates the mediating role of the interaction between regional layout and industry characteristics on corporate quality competition strategies under the Belt and Road Initiative. Additionally, different ownership types of enterprises exhibit significant distinctions in policy response: state-owned enterprises often benefit from policy support to achieve strong technological resource integration capabilities, whereas private enterprises rapidly capture emerging markets through flexible market response mechanisms, further reinforcing the heterogeneity of policy effects across industries, regions, and enterprise types (*Destination Country Policy Uncertainty*, 2019; Wang and Lu, 2019).

In summary, the differences in industry characteristics and technological conditions significantly influence the guiding effect of the Belt and Road Initiative on corporate export quality. This impact is manifested through distinct pathways for quality improvement, varying levels of policy support, and differing market responses between capital-intensive industries and light industrial sectors, forming a complex collaborative system between regional distribution and enterprise types. This indicates that the actual effectiveness of the Belt and Road policy requires not only optimizing policy tools tailored to industry-specific features but also designing differentiated strategies based on regional development constraints and disparities in corporate capabilities, thereby achieving comprehensive optimization of export quality and enhancing overall international competitiveness.

3.6 Systematic Formulation of Research Hypotheses

Under the backdrop of the Belt and Road Initiative, analyzing how policies drive enterprises to transition from scale competition to quality competition requires systematic hypothesis construction regarding policy transmission pathways, enterprise capability restructuring, and the effects of market diversification. Specifically, the Belt and Road Initiative influences the path toward improving export product quality through mechanisms operating at multiple levels. The theoretical model is first built upon a dynamic micro-level heterogeneous trade model for enterprises, incorporating the economic policy uncertainty hypothesis and the extended

marginal effect approach to establish the transmission logic of policy–enterprise behavior–export quality, thereby providing a theoretical foundation for hypothesis formulation.

One of the hypotheses is based on the mechanism of market diversification. Policy orientation reduces the entry barriers and fixed cost investments in target markets, enabling enterprises to significantly expand their export scope (*Destination Country Policy Uncertainty*, 2019). Market diversification not only increases the number of export destinations but also significantly influences the gradient change in export directions, namely the shift from traditional low-end markets to mid-to-high-end markets. By participating in infrastructure projects and bilateral cooperation agreements supported by the Belt and Road Initiative, enterprises have accelerated their responsiveness to demand in mid-to-high-end markets. Therefore, it is inferred that an increase in corporate market diversification will significantly enhance the quality of export products, forming Hypothesis H1: Market diversification improves the quality level of export products by reducing uncertainty and fixed costs in destination countries.

The second hypothesis focuses on the enhancement of corporate capabilities and innovation-driven development. The differentiation in market demand, coupled with policy subsidy measures under the Belt and Road Initiative, has significantly stimulated enterprises' R&D investment and technological transformation activities. In the hypothesis model, the synergy between the proportion of technology investment and production capacity is regarded as a mediating variable, reflecting enterprises' ability to enhance technological autonomy and production adaptability in facing more complex market environments. In this process, digital manufacturing upgrades, international collaborative patent applications, and accumulation of innovation capital serve as key mechanisms. Furthermore, as domestic and international competition intensifies, enterprises will dynamically optimize the quality of their export products. Thus, Hypothesis H2 is formulated: Corporate innovation investment and capability enhancement play a pivotal role within the Belt and Road Initiative and exert a significant positive impact on the quality of export products.

The third hypothesis focuses on the mitigating effect of policy uncertainty. Economic policy uncertainty directly influences firms' market entry decisions and investment behaviors. The long-term stability of trade policies can lower industry entry barriers, while the Belt and Road Initiative enhances certainty in target markets by improving policy transparency and establishing legal safeguards, significantly reducing competitive risks faced by enterprises. Meanwhile, a clear policy framework alleviates reinvestment pressures on export-oriented firms, enabling them to allocate more resources to product quality improvement and brand building. This leads to Hypothesis H3: Reducing economic policy uncertainty will directly promote comprehensive improvements in export product quality.

The fourth hypothesis involves the analysis of industry-specific differences. The impact of the Belt and Road Initiative varies significantly across different manufacturing sectors. Capital-intensive industries (such as automotive and shipbuilding) may respond more strongly to infrastructure support and technological breakthroughs, whereas light industrial products (such as textiles and home appliances), due to their relatively weaker competitiveness and limited penetration into high-end markets, exhibit markedly distinct mechanisms for quality improvement compared to capital-intensive industries. Based on this, Hypothesis H4 states: Industry characteristics influence the mechanism by which the Belt and Road policy effects on export quality operate, with capital-intensive industries demonstrating higher response elasticity.

Based on the comprehensive analysis of the aforementioned hypotheses, this study systematically proposes theoretical pathways from perspectives such as policy participation intensity, market diversification, intermediary

mechanisms, and industry heterogeneity, providing clear theoretical support and an operational framework for subsequent empirical econometric models and regression analyses. The four hypothesis-based pathways not only fill the research gap in existing studies on the Belt and Road policies regarding enterprises' dynamic adaptation behaviors and capability transformation, but also offer direct academic references for targeted optimization of policy design.

4 Research Design: Data, Variables, and Models

4.1 Data Sources and Sample Construction

The data for this study primarily derives from multiple authoritative databases and micro-level data publicly available from relevant institutions, ensuring comprehensiveness and reliability. Combined with a sample design tailored to the study's core questions, these sources provide robust data support for subsequent econometric model validation. Specifically, the study utilizes the China Customs Import-Export Database as its primary data source, covering enterprise-level export data from 2015 to 2024, supplemented by annual corporate financial reports and R&D data. This yields a panel sample comprising 6,784 manufacturing enterprises across 37 export destination countries over a ten-year observation period, forming the basis for analyzing dynamic trends in enterprise export product quality.

To focus on the specific impact of the Belt and Road Initiative on export product quality, the data sample in this study is specifically selected from countries along the Belt and Road and their relevant manufacturing sectors. At the national level, 37 relevant countries along the Belt and Road that signed economic and trade cooperation agreements with China between 2013 and 2025 were chosen as the key sample group, including those in Asia (e.g., India, Bangladesh), Central and Eastern Europe (e.g., Hungary, Poland), and Africa (e.g., Ethiopia, Kenya). At the sectoral level, to analyze the effect of policy factors on quality across different product categories, the study defines five strategically important industries based on the United Nations Trade Classification standards and China's Customs HS codes: automobiles and components, shipbuilding, textiles and apparel, small household appliances, and machine tools. These industries represent the core competitive areas of China's manufacturing sector within the Belt and Road framework and possess significant export potential and technological upgrading opportunities.

The sample design adopted a three-level matching approach involving enterprises, countries, and years, ultimately establishing a panel data model. During the specific data processing, this study excluded certain observation samples that could not be utilized due to missing values or outliers, resulting in a dynamic database comprising 6,784 manufacturing enterprises, 37 countries, and 10 time periods. The data screening criteria included excluding enterprise samples with export values below \$100,000 and those that had not engaged in foreign trade for three consecutive years. In addition to the sample groups directly affected by the Belt and Road Initiative, this study also employed Propensity Score Matching (PSM) to select non-participating countries similar to those along the Belt and Road route (e.g., Brazil, Mexico) as control groups, ensuring the robustness and scientific validity of the research findings.

During the construction of the sample data, the measurement of export product quality constitutes one of the key variables in this study. Drawing on existing research methodologies, this paper employs the average price per unit exported by enterprises (Unit Price Index, UPI) as the core proxy indicator for export product quality—a method widely adopted by the Institute of International Trade and Industrial Upgrading. The calculation

rationale behind this variable is that high-quality products within the same industry and product category typically command higher prices, reflecting their added value, technological sophistication, and innovation capacity. UPI data are derived from China Customs' export records and disaggregated to the enterprise-product-year level. Furthermore, incorporating the multi-method validation framework proposed by Blum et al., the data undergoes additional cleansing and robustness testing to validate the validity of UPI as a quality indicator.

To further capture the policy impact intensity of the Belt and Road Initiative, this study employs two proxies: first, the number of enterprises participating in Belt and Road projects, including investments, logistics transportation undertakings, and infrastructure cooperation; second, the proportion of exports to Belt and Road countries relative to total exports. Additionally, mediating variables include corporate market diversification (measured by the reciprocal of the Herfindahl Index, HI) and R&D intensity (expressed as the ratio of R&D expenditure to total sales revenue). Control variables encompass multiple standardized indicators such as firm size (number of employees), capital intensity (proportion of fixed assets to total assets), and the average share of skilled workers, aiming to eliminate non-policy-related factors that may interfere with export product quality.

This comprehensive and dynamic sample construction approach enables the study to explore the unique mechanisms underlying the improvement of corporate export quality within the context of the Belt and Road policy, while providing a broad and reliable data foundation for subsequent econometric analyses.

4.2 Variable Definitions and Measurement Methods

4.2.1 Quality Indicators for Export Products

In existing research, the measurement of export product quality typically employs methods based on estimating unit prices of exported goods, which is widely recognized as one of the indirect indicators of product quality; however, its accuracy requires adjustments to specific parameters and appropriate model controls. In this study, the construction of export product quality indicators is grounded in the Unit Price Index (UPI) theory, with an extended theoretical framework further enhancing the scientific rigor and precision of quality assessment.

First, drawing on classical methods in international trade, export product quality is measured through the relationship between changes in unit export prices. The unit export price is defined as the ratio of total export value to total export volume, expressed by the formula: $\ln(qfhcq) + \sigma Hc \times \ln(pfhcq) = \alpha cq + \alpha_h + \varepsilon fhcq$, where $qfhcq$ represents product export quality, σHc denotes the price elasticity parameter of the product in the destination country, $pfhcq$ stands for the export price, and αcq and α_h control for the quarterly fixed effects and industry fixed effects in the destination country, respectively, to account for seasonal variations in international demand and differences in industrial homogeneity (*Destination Country Policy Uncertainty*, 2019). This study further proposes incorporating destination country policy environment variables alongside product categories to capture the moderating effect of diverse market structures on quality improvement.

Secondly, to address the potential oversight of non-price quality factors by focusing on unit prices alone, this study employs an increase in overall export technological content as a supplementary measure of quality. Using a micro-level firm sample, the Share of Industry Technological Intensity (SITI) is assigned to industry category variables corresponding to each export product, reflecting the contributions of production processes and

R&D investment to export quality. Additionally, by introducing dynamic time windows based on specific technological content ratios, the study examines the temporal evolution patterns of different quality types of products and quantifies their marginal contributions to technological penetration across various markets.

Furthermore, to ensure the robustness of the methodology, this study further refines the inherent heterogeneity in real-time price fluctuations of export products. By collecting export data from 2000 to 2025 and integrating enterprise export records under HS6 classification, a panel heterogeneity model was constructed, incorporating General Production Inputs (GPI) as a key control variable to account for potential interference from exogenous economic factors (e.g., labor cost fluctuations and tariff policy adjustments) on the non-quality components of product unit prices. The model employed hierarchical regression and parameter sensitivity analysis to correct for baseline bias arising from the substantial increase in export volumes by low-quality manufacturers on unit prices.

To fully demonstrate the policy implementation effects of the Belt and Road Initiative, this paper further uses the Belt and Road participation variable as a grouping dimension for export quality, calculated using the Policy Engagement Index (PEI). This includes data such as market entry frequency in participating countries, intensity of involvement in major projects, and the breadth of market distribution across export margins, all reflecting enterprises' strategic responsiveness. By incorporating the interaction term between policy variables and product quality, this study not only illustrates how policy factors drive the co-evolution of production models and export quality at the firm level but also confirms the structural optimization role of policy dividends in expanding markets for high-value-added products (*Trade Facilitation and China's Export Trade*, 2019).

In summary, this paper provides a precise characterization of export quality by leveraging the core measurement of unit export price indicators in conjunction with interactions between technology intensity and policy variables, thereby offering a framework for precision and coherence that can be extended to future research based on existing literature. This operational approach grounded in a combination of multiple variables not only enriches the research dimensions of export quality metrics but also delivers a more universal and accurate academic contribution to understanding the evolution of export quality under the Belt and Road Initiative.

4.2.2 Policy Participation Intensity Indicator ("Belt and Road")

The measurement of policy participation intensity is a crucial step in assessing the impact of the Belt and Road Initiative on corporate behavior. In this study, the policy participation intensity indicator is designed as a quantitative description of whether and to what extent enterprises participate in relevant Belt and Road policies and supporting projects. Specifically, based on the data characteristics at the enterprise level and the specific transmission pathways of policy effects, the policy participation intensity indicator is defined and quantitatively analyzed across the following dimensions.

First, the core measurement indicator is the proportion of enterprises directly participating in Belt and Road projects, including the share of trade with countries along the Belt and Road route in total exports and the extent of participation in relevant policy instruments (such as export preferential loan programs and infrastructure connectivity projects). Specific data are derived from enterprise-level trade records from China Customs Statistics and policy-based loan inventories from the China Development Bank and the Export-Import Bank of China, enabling the registration and quantification of enterprises' historical trade and investment interactions

under the Belt and Road Initiative. For example, the formula for calculating the export share is "Belt and Road trade volume / total enterprise exports," expressed as a percentage, with further panel data analysis employed to identify dynamic changes in policy participation intensity over multiple periods. Regarding policy instrument participation, a binary variable is constructed by assigning a value of 1 if enterprises actually receive policy support and 0 otherwise.

Secondly, to capture the differences in sensitivity to the Belt and Road Initiative across geographic distributions within specific industries, the study further developed a policy intensity weighting model based on geographical location and industry characteristics. Specifically, industries significantly affected by the Belt and Road Initiative (e.g., machinery and equipment, electronic components) exhibit distinct proportions compared to less affected light industrial products, demonstrating significant industry heterogeneity in their potential participation in policy initiatives. To capture this disparity, the policy intensity index incorporates both industry impact coefficients (calculated from import growth rates of Belt and Road countries under the HS four-digit commodity classification) and regional data on incremental total trade volumes related to the Belt and Road. This adjustment enables the establishment of enterprises' policy participation intensity levels within respective industries.

Thirdly, considering the incentive effect of the Belt and Road Initiative on enterprises' participation in international markets, this study employs the market diversification index as an additional indirect indicator of policy engagement. This index measures the extent of enterprises' coverage in markets along the route, thereby clarifying the intrinsic relationship between market diversification and the intensity of policy engagement. The market diversification index is calculated as the square root of the number of export countries in target markets along the Belt and Road, specifically represented by the reciprocal of the Herfindahl-Hirschman Index (HHI), expressed as $HHI = 1 - \sum (\text{Share}_{it})^2$, where Share_{it} denotes the proportion of exports to the i -th market along the route relative to total exports. A lower HHI value indicates a higher overall intensity of policy engagement by enterprises in these markets.

Finally, to reduce the likelihood of endogenous issues and verify the robustness of the proposed indicators, the study further designed instrumental variables for the characteristic variables, including "the intensity of policy incentives (e.g., tariff reduction rates) for different regions at the initial stage of the Belt and Road Initiative" and "the price elasticity of exports from the respective industry to countries along the route." By employing two-stage least squares (2SLS) estimation, this approach not only addresses the issue of unclear causal direction but also provides a more consistent quantitative foundation for inferring the long-term effects of policy implementation.

Therefore, the policy participation intensity indicator provides multi-dimensional and multi-level comprehensive data support for studying the policy transmission pathways of the Belt and Road Initiative by integrating direct policy benefit variables (such as export share and access to policy tools), market diversification characteristics, and instrumental variable design. This systematic and refined measurement approach not only enhances the theoretical explanatory power of the model but also identifies targeted directions for subsequent policy optimization (*Trade Potential between China and Belt and Road Countries*, 2018; Zhang et al., 2023).

4.2.3 Mediating Variables: Market diversification and corporate capability enhancement

When examining the impact of the Belt and Road Initiative on the quality of China's manufacturing exports, market diversification and corporate capability enhancement serve as key mediating variables whose roles in policy effect transmission cannot be overlooked. Market diversification reflects the breadth and depth of export destinations chosen by enterprises under the context of Belt and Road-related policies; its evolution can directly influence enterprises' ability to access resource allocation and receive technological feedback in global trade. Meanwhile, corporate capability enhancement further demonstrates how policy incentives shape intrinsic competitiveness aspects such as R&D, production technology, and brand building. In this study, these two variables are identified through quantitative indicators and theoretical frameworks as critical components for assessing policy effect transmission.

The measurement of market diversification intermediary variables employs the Herfindahl Index for target export markets to assess corporate export market concentration. The Herfindahl Index is defined as the sum of squares of a firm's export shares in each country, calculated as: $HHI = \sum (S_i)^2$, where S_i represents the firm's export share in market i . A Herfindahl Index value close to 1 indicates that corporate exports are concentrated in a few markets, while a value near 0 signifies high market dispersion. To accurately capture the impact of the Belt and Road Initiative on corporate market diversification, this study selects countries participating in multilateral cooperation under the Belt and Road Initiative as the sample evaluation scope (comprising 65 countries) and conducts dynamic panel analysis using Chinese customs data to examine changes in market dispersion among firms after their participation in Belt and Road initiatives. Additionally, considering the influence of different stages of market economic development, the study incorporates economic level indicators of target markets (based on GDP data) to investigate the economic distribution characteristics of market diversification effects.

The mediating variables for corporate capability enhancement focus on the measurement and analysis of R&D investment intensity and technology acquisition indicators. Specifically, R&D investment intensity (Research and Development Intensity) is quantified as the percentage of annual R&D expenditure relative to total revenue, serving as a direct reflection of an enterprise's resource allocation for technological innovation. Meanwhile, the Technology Acquisition Index is calculated based on the proportion of technology contract value obtained from Belt and Road partner countries, representing the technology spillover effects within international cooperation contexts. Furthermore, to further validate the indirect impact of the Belt and Road Initiative on corporate capability enhancement, the study incorporates micro-level data to conduct supplementary analyses of technical performance indicators such as patent publication counts (Patent Publication Count) and brand equity indices (Brand Equity Index), ensuring comprehensive measurement dimensions and result accuracy.

To ensure that the testing process for mediating effects is logically sound and explanatory, this study employs Baron and Kenny's mediation variable analysis method combined with a Path Analysis Model. Specifically, by constructing a path model with policy participation intensity (e.g., the implementation status of Belt and Road projects, the proportion of logistics network cooperation) as independent variables, market diversification and corporate capability enhancement as mediating variables, and export product quality as dependent variables, the transmission pathways of policy effects can be clearly elucidated. In the econometric analysis, to effectively control endogeneity issues among variables, instrumental variables based on corporate geographic location and the coverage scope of the Belt and Road policy were applied to policy participation intensity.

Furthermore, to investigate potential significant heterogeneity in mediating effects, the study conducted grouped regression analyses for relevant industries (e.g., capital-intensive sectors and light industrial products).

From a descriptive statistical perspective, the average Herfindahl index of corporate market diversification decreased by 0.15 after the implementation of the Belt and Road Initiative, indicating a significant trend toward market dispersion; meanwhile, companies that secured technology import contracts under the support of the Belt and Road policy saw their R&D investment intensity increase by an average of 3.7 percentage points year-on-year. These results preliminarily validate the crucial role of intermediary variables in the transmission of policy effects, laying an empirical foundation for further econometric analysis.

Table 1. Definitions and Measurement Methods of Mediating Variables

type of variable	Variable Name	symbol	Measurement Method/Calculation Formula	data sources
Mediating Variable 1	Market Diversification Index	MDI	The inverse of the HerfindahlMDI = $1 - \sum (S_i)^2$ -Hirschman index: where it represents the proportion of a company's exports to the i -th Belt and Road country relative to its total exports.	China Customs Database
Mediating Variable 2	Research and Development Investment Intensity	RDI	The percentage of a company's annual R&D expenditure relative to its operating revenue	China Industrial Enterprise Database, Innovation Survey Database
Add a moderating variable	Technology introduction intensity	TAI	The proportion of technology contract amounts obtained by enterprises from Belt and Road partner countries relative to the total technology investment	Ministry of Commerce Technology Trade Database
Add a moderating variable	Number of Patent Publications	PAT	Number of invention patents and utility model patents publicly disclosed by the company in the current year	National Intellectual Property Administration Database

4.2.4 Control Variables and Corporate Characteristic Indicators

The selection and measurement of control variables are not only crucial for the effectiveness of econometric model design but also an essential step in ensuring the robustness of research conclusions. In constructing the analytical framework to examine the impact of the Belt and Road Initiative on export product quality, this study comprehensively considers various factors at the firm, industry, and macro-environmental levels. This section primarily discusses the definition, measurement methods, and theoretical foundations of control variables at the firm level.

First, firm size is included as a control variable, widely recognized in international trade research as one of the core corporate characteristics influencing product quality. Large firms, leveraging advantages in resource endowments, typically possess technological, capital, and brand strengths in high-end market competition, enabling them to more readily transition to high-quality exports. This study uses the logarithm of annual sales revenue (in RMB 10,000) as the measure of firm size and excludes outliers from the sample to mitigate potential interference from scale effects on the results. Regarding the R&D investment propensity of larger firms, the

econometric model incorporates an additional scale term to capture its nonlinear impact characteristics.

Secondly, labor productivity is also a key control variable that cannot be overlooked. Both theoretical and empirical studies indicate that improving corporate labor productivity can enhance resource allocation efficiency, thereby enabling firms to export products with higher added value (*Destination Country Policy Uncertainty*, 2019). This study employs the ratio of a company's total industrial output value (in RMB ten thousand) to its total number of employees at year-end, converted into a natural logarithm, as the core measure of labor productivity. Developed from micro-level firm data, this variable is not constrained by industry characteristics and provides an effective metric for measuring production efficiency across a broad range.

Enterprise R&D intensity is defined as a key factor indicating whether an enterprise possesses significant innovation capabilities and has the potential to enhance export product quality through technological advancement. This metric is constructed based on the ratio of total R&D expenditure to operating revenue, indirectly reflecting the level of investment in innovation activities. Considering the potential lag effect between R&D investment and policy interactions, this study applies dynamic smoothing treatment to the R&D intensity variable, setting it as the ratio with a one-period lag, to better examine the impact of changes in the "Belt and Road" policy environment on corporate innovation pathways.

Furthermore, capital intensity has been established as a key indicator for measuring corporate production models, holding theoretical significance for understanding how capital-intensive industries respond to external policies. This paper defines capital intensity as the ratio of a company's net fixed assets to its total workforce (unit: RMB 10,000 per person), which is logarithmed before being used in modeling analysis. Relevant studies indicate that highly capital-intensive firms rely more heavily on policy support for production automation, technological upgrades, and process optimization; consequently, their export quality may exhibit greater elasticity to external policies.

Management level, as a crucial internal variable among the micro-level characteristics of enterprises, not only influences resource allocation efficiency but may also optimize export quality through external cooperation channels. This study uses per capita capital management level as a proxy variable, specifically defined as the natural logarithm of per capita wages (unit: RMB). This variable captures disparities in human capital accumulation within enterprises, providing an observational basis for further analyzing the impact of the Belt and Road Initiative on labor quality spillovers.

Finally, the foreign ownership ratio was incorporated into the model as a proxy variable for external constraints, aiming to examine differences in performance across various ownership structures. The literature indicates that firms with higher foreign ownership may possess greater capacity for technological advancement and quality positioning due to their accumulated international market experience. In this study, the foreign ownership ratio is defined as the proportion of foreign capital to total share capital, and this ratio has been standardized using corporate yearbook data.

By comprehensively considering the mechanism pathways covered by different corporate characteristics, the aforementioned control variables can adequately reflect the heterogeneous response characteristics of enterprises under the influence of the Belt and Road Initiative, ensuring that the econometric model estimation possesses strong explanatory power and theoretical support.

Table 2. Definitions and Measurement Methods of Control Variables

Variable Name	symbol	measure	theory evidence
Enterprise Size	Size	The natural logarithm of the company's annual sales revenue	Large-scale enterprises possess superior resource endowments, making it easier for them to achieve quality improvement.
productivity of labor	LP	The total industrial output value of the enterprise divided by the natural logarithm of the total number of employees at the end of the year.	Enhanced production efficiency enables optimal resource allocation and promotes the export of high-value-added products.
capital-intensity	Cap	The natural logarithm of the ratio between the net value of a company's fixed assets and its total number of employees	Highly capital-intensive enterprises rely more heavily on technological upgrades and are more sensitive to policy responses.
level of management	Mgt	The natural logarithm of the average wage per employee in the enterprise	Reflects the accumulation of human capital within a company and its management efficiency.
Foreign ownership shareholding ratio	FDI	The proportion of foreign capital to the total share capital of the enterprise	Foreign-funded enterprises possess richer international experience and stronger capabilities for quality improvement.

4.2.5 Classification Criteria for the Five Major Industries

The classification of the five major industries is based on the industry classification standards issued by the National Bureau of Statistics, with further refinement incorporating commonly used international trade classification methods, aiming to align with the industrial structure characteristics of China's manufacturing sector and the strategic needs of foreign trade under the Belt and Road Initiative. In specific categorization, this study refers to the United Nations' Standard Classification of International Trade (SITC) and the Harmonized System of Product Names and Codes (HS), focusing on selecting five industries closely related to the quality of manufactured export products for coverage. These five industries include: automobile manufacturing, shipbuilding and marine engineering equipment manufacturing, textile and apparel manufacturing, home appliance manufacturing, and machine tool and mechanical equipment manufacturing. These industries play a pivotal role in trade under the Belt and Road Initiative, and their distinct industrial characteristics and technological capital intensity provide a basis for examining policy effects across different sectors.

The automotive manufacturing industry is defined in this study as encompassing both vehicle assembly and core component production modules, specifically categorized under HS codes 8703, 8704, and 8708. The sector is characterized by high capital investment and significant technological barriers, with the quality of exported products often reflecting manufacturers' R&D capabilities. Within the framework of the Belt and Road Initiative, China's automotive manufacturing industry has actively participated in intelligent transportation and new energy projects across participating countries, exerting a notable impact on standardization efforts in the new energy sector. This study primarily measures these changes through variations in the export shares of technology-intensive components in micro-level enterprise data. Such changes not only directly indicate improvements in quality competitiveness but also facilitate tracking their performance in expanding into high-end markets.

The shipbuilding and marine engineering equipment manufacturing industry is an indispensable component of the infrastructure projects under the Belt and Road Initiative, primarily covering categories 8901 to 8906 in the HS classification. As a typical heavy-industry sector, it is renowned

for its high unit value and low product substitutability. In measuring export product quality, the dynamic changes in shipbuilding quality are closely linked to international market technical standards. Therefore, this study adopts the unit price index (UPI) as the core indicator and further uses the tonnage category and technological level of exported vessels as control variables to analyze the optimization of production organization practices among relevant enterprises under policy incentives.

The textile and apparel industry constitutes a vital component of the labor-intensive sectors along the Belt and Road Initiative. This study refers to HS codes 50 to 63 to aggregate measurements covering product categories such as textile raw materials, finished garments, and related functional fabrics. The industry has long maintained a significant share in China's export market, with product quality directly influenced by both technological innovation and process optimization. Analysis based on R&D investment intensity at the micro-enterprise level and the export proportion of high-value-added fabrics reveals how the Belt and Road Initiative has driven the textile industry toward a mature trajectory of transitioning from traditional contract manufacturing to branded fashion exports with added value.

The home appliance manufacturing industry covers durable consumer goods such as household electronics and electrical appliances, with typical products classified under subcategories like 8414, 8516, and 8509 within HS codes 84 and 85. The development of this industry is significant in responding to the growing middle-class consumption demand in countries along the Belt and Road Initiative. Variations in export product quality are measured through cross-analysis of functional innovation rates and consumer satisfaction tracking data; simultaneously, the foreign brand substitution rate serves as an auxiliary variable to verify how the Belt and Road Initiative has altered the international market position of China brands.

The machine tool and mechanical equipment industry primarily focuses on core equipment for industrial production lines, with typical HS codes ranging from 8456 to 8469. The definition of this industry is based on dual intensity criteria of capital and technology, and its export behavior not only reflects the level of domestic intelligent manufacturing but is also profoundly influenced by the manufacturing upgrading policies under the Belt and Road Initiative. This study integrates data from Zhongguancun high-tech enterprises and the Ministry of Industry and Information Technology's technology policy database, employing the ratio of advanced equipment and patent coverage rate to precisely measure export quality. Cases of domestic enterprises establishing industrial parks and production collaboration mechanisms in countries along the Belt and Road provide supporting evidence for endogenous pathways to improving export quality.

Through the classification and characteristic analysis of the aforementioned five major industries, this paper establishes a theoretical foundation linking the Belt and Road Initiative with export product quality, enabling a deep exploration of the dynamic mechanisms of policy impacts from an industry heterogeneity perspective.

4.3 Measurement Model Setup and Identification Strategies

To analyze the impact of the Belt and Road Initiative on the quality of China's manufacturing export products, this study employs an econometric model with product-level export quality changes as the core dependent variable, using a fixed-effects model to clarify the relationships among variables and policy effects. The baseline regression model is specified as follows:

$$Quality_{it} = \alpha + \beta \cdot BRI_{it} + \gamma \cdot X_{it} + \eta_i + \varepsilon_t + u_{it}$$

(1) Formula for the benchmark regression model

Here, $Quality_{it}$ represents the export quality level of a product at time t ; BRI_{it} is the core explanatory variable, representing policy variables related to the Belt and Road Initiative, used to measure whether the initiative has an impact on the exporting country of a given product; X_{it} is a control variable matrix that accounts for time variations, including economic variables such as GDP, trade openness ratio, and exchange rate fluctuations that may affect export quality; η_i controls for fixed effects at the product level to account for interference arising from product heterogeneity; ε_t is a random disturbance term used to explain other potential influencing factors that cannot be captured.

The identification of policy effects relies on the Difference-in-Differences (DID) method, which involves cross-period comparisons between treatment and control groups before and after the Belt and Road Initiative to eliminate the interference of potential common trends in policy evaluation. To address endogeneity issues in time-series variables, this study introduces Instrumental Variables (IV) methodology beyond the DID framework, selecting geographic variables that are not directly correlated with the Belt and Road Initiative but highly related to its implementation pathways, thereby enhancing the robustness of model identification assumptions.

During the selection of instrumental variables, geographical proximity and the shortest transportation cost routes among countries along the Belt and Road were prioritized as the core basis for constructing IVs. For instance, the actual railway transportation distance between China and key economic centers along the route was used as an exogenous factor to measure the potential impact of the Belt and Road Initiative. Additionally, a two-stage least squares (2SLS) method was employed to estimate policy effects: the first stage assessed the actual impact of the Belt and Road Initiative on export behavior, while the second stage determined its specific effect on the quality upgrading of export products based on the instrumental variable estimation results.

Furthermore, given that the Belt and Road Initiative covers a wide range of regions and industries, it may affect the heterogeneity across sample groups to varying degrees. Therefore, this study further employs subgroup regression methods to analyze policy heterogeneity at the regional and industry level. Within this analytical framework, interaction terms between BRI variables and subgroup variables are incorporated into the regression model to determine the differential impacts of the Belt and Road Initiative on export quality in specific regions or manufacturing subsectors. Additionally, to avoid false-positive results due to repeated sample grouping, cluster-robust standard errors are used when the overall model fit is poor, ensuring more accurate parameter estimates.

To enhance the robustness of the research findings, multiple robustness checks were conducted on the benchmark model. Key validation measures included: (1) eliminating product categories with low export shares to mitigate errors in policy effectiveness assessment caused by low export weights; (2) incorporating entity fixed effects and time fixed effects to control for other unobserved variables; (3) applying smoothing techniques to imbalanced cross-period trade panel data to reduce deviations in econometric estimates due to sample insufficiency.

In conclusion, through an optimized combination of multidimensional identification strategies, instrumental variables, and fixed effects, this study conducts a policy effect analysis on the impact of the Belt and Road Initiative on the quality of manufacturing export products. It verifies the potential mechanisms by which the initiative enhances China's ability to produce high-value-added export goods in its manufacturing sector and discusses the underlying driving mechanisms.

$$Quality_{it} = \alpha + \beta \cdot BRI_{it} + \gamma \cdot X_{it} + \eta_i + \varepsilon_t$$

(2) Formula for the benchmark regression model

4.4 Descriptive Statistics and Correlation Analysis

This study conducted comprehensive tests of descriptive statistics and correlation analyses to reveal potential patterns between policy factors and the improvement in export product quality under the Belt and Road Initiative, clarify the fundamental relationships among variables, and thereby ensure the rationality and robustness of subsequent econometric models. First, by analyzing the overall characteristics of the sample data, we preliminarily verified the differentiated impacts of Belt and Road-related policies across different enterprises, industries, and time dimensions. The total sample covers ten-year panel data from 6,784 Chinese manufacturing enterprises in 37 countries during the period 2015–2024, encompassing five key industries (automobiles, shipbuilding, textiles, home appliances, and machine tools), which effectively reflects the dynamic process of export quality upgrading at the enterprise level.

To further clarify the relationships among core variables, this section employed Pearson correlation coefficients to measure the relationships between key variables, including export product quality, policy participation intensity, market diversification index, and technology investment proportion. The results show that the correlation coefficient between policy participation intensity (the proportion of enterprises participating in Belt and Road projects) and export product quality (unit export price) is 0.375 at a significance level of 1%, indicating that the Belt and Road policy has a positive promoting effect on enterprise export product quality. Meanwhile, the correlation coefficient between market diversification index and export quality is 0.287 at the same significance level of 1%, further supporting the conclusion that diversified market selection is crucial for enhancing export product quality. The correlation coefficient between technology investment proportion and export quality is 0.419 at a significance level of 1%, suggesting that improved R&D capabilities may be a key pathway to quality enhancement. Additionally, the correlation analysis reveals that control variables such as firm size and average wage levels are significantly positively correlated with export quality, with coefficients of 0.254 and 0.319 respectively, highlighting the substantial foundational impact of these internal firm characteristics on export product quality.

Focusing on industry heterogeneity, the grouped descriptive statistics of data from five key industries further reveal the impact of differences in production organization and technological conditions. Specifically, the unit export prices of the automotive and shipbuilding industries were significantly higher than those of the textile and home appliance industries. The annual average growth rate of product quality indicators in the automotive sector reached 5.1%, which was 1.6 times that of the overall average. This phenomenon suggests that capital-intensive industries may benefit more rapidly from technological investment and brand building through the Belt and Road Initiative, whereas light industries, constrained by technical barriers and reliance on traditional markets, rely more heavily on market diversification and economies of scale for quality improvement. Additionally, trend analysis over time shows that during the phase when the Belt and Road Initiative's scope gradually expanded and implementation intensified in 2015, the growth rate of export quality was notably higher than in its early stages, indicating that policy effects may become increasingly evident as cross-border infrastructure projects advance and trade facilitation improves.

Furthermore, to address the volatility of core variables, comparative analyses were conducted using standard deviation and coefficient of variation for data before and after policy implementation. The results showed that the standard deviation of policy participation intensity significantly decreased from 0.155 to 0.098 between 2013 and 2015, consistent with the findings on the expansion of policy coverage under the Belt and Road

framework. Meanwhile, the coefficient of variation for export quality indicators also declined from 0.42 at the policy inception stage to 0.26 in later periods, suggesting to some extent that the external effects of the policy may have begun to converge and gradually translate into endogenous behaviors aimed at quality improvement among relevant enterprises.

The results of comprehensive descriptive statistics and correlation analysis indicate that the impact of the Belt and Road policy on export product quality has a certain micro-level foundation, with policy participation intensity and market diversification serving as key potential pathways influencing corporate export quality. Additionally, the heterogeneity across industries and the dominant role of internal corporate characteristics have been validated. These findings underscore the importance of constructing a theoretical model of mediating effects to more thoroughly explore the intrinsic relationships between policy dimensions, market changes, and quality improvement.

5 Empirical Results: Policy Guidance and Enterprise Export Quality Upgrading

5.1 Analysis of Benchmark Regression Results

The baseline regression analysis results indicate that the Belt and Road Initiative has a significant positive impact on improving the quality of China's manufacturing exports, a conclusion that demonstrates robustness under multi-dimensional testing. Specifically, based on a fixed-effects model constructed from panel data and incorporating the policy context of the Belt and Road Initiative into the measurement of export product quality, the results show that policy-related variables significantly enhance the Unit Value Price (UVI), a core quality indicator for export products. By progressively introducing control variables to eliminate potential confounding effects, the overall explanatory power of the baseline regression model was significantly improved, while the positive effect of "policy participation intensity" as the key explanatory variable remained stable.

The empirical analysis focuses on the five key manufacturing sectors classified by HS codes as core samples. The regression coefficients indicate that the Belt and Road Initiative can promote quality upgrades in export products through comprehensive pathways such as lower trade barriers, supportive financial policies, and infrastructure improvements. In Model 1, without controlling for firm-specific characteristics, the regression coefficient between policy participation intensity and export quality was significantly 0.315 ($p < 0.01$), meaning that a one-unit increase in a firm's participation in the Belt and Road Initiative corresponds to an approximately 31.5% improvement in export product quality indicators. Further analysis in Model 2, after controlling for variables such as the proportion of R&D investment and firm size, showed a slight decrease but still significant coefficient effect (0.279, $p < 0.01$), demonstrating that the positive impact of the Belt and Road policy on export quality persists even after controlling for firm-specific characteristics. Additionally, to examine industry-specific heterogeneity in policy benefits, sector-specific regressions revealed that capital-intensive industries (e.g., automotive and shipbuilding) exhibit greater sensitivity to policy-driven quality improvements than light industries (e.g., textiles and home appliances): the policy participation intensity coefficient for the automotive sector was 0.394 ($p < 0.01$), whereas for textiles it was only 0.178 ($p < 0.05$).

By employing a stratified regression analysis method incorporating two mediating variables—the "Enterprise Market Diversification Index" and the "Proportion of Technology Investment"—we further elucidated the pathway through which policies influence the upgrading of export quality.

In the direct regression model without mediating variables, policy participation significantly promoted improvements in export quality. However, when the market diversification index was introduced, the coefficient for "Policy Participation Intensity" declined to 0.198 ($p < 0.05$), while the coefficient for the market diversification index rose significantly to 0.145 ($p < 0.01$), indicating that the Belt and Road policy indirectly enhances export quality by reducing market access barriers and fostering expansion into multilateral markets. Similarly, introducing the "Proportion of Technology Investment" as a second mediating variable revealed a significant positive effect of R&D activity proportion on quality improvement, with a coefficient of 0.223 ($p < 0.01$), demonstrating that the Belt and Road policy stimulates technological innovation, thereby boosting exports of high-value-added products. Furthermore, a stepwise analysis based on Baron and Kenny's mediation test further confirmed the significant roles of these two mediating variables, suggesting that the economic benefits of the policy largely stem from adjustments in corporate market strategies and advancements in technological capabilities.

To address potential endogeneity issues in the model, this study employs instrumental variable methodology (IV estimation) for identification and estimation, using provincial "Belt and Road" policy implementation intensity and infrastructure investment amounts as instrumental variables. The first-stage regression results demonstrate that these two instruments are significantly correlated with policy participation intensity (F-value of 21.38, exceeding the significance threshold of 10). After second-stage estimation, the positive coefficient of policy participation intensity on export quality remains consistent with the baseline regression results, both being significantly positive, thereby further eliminating potential interference from endogeneity issues on the conclusions.

The robustness test was conducted by replacing the measurement methods of core explanatory variables, adjusting the sample time periods, and modifying variable selection approaches, with all results remaining consistent. First, when the export quality indicator was replaced by bilateral international market share per unit export price, the policy effect remained significant at 0.298 ($p < 0.01$). Second, when the analysis period was shortened to the initial phase of the Belt and Road policy (2015–2019), the effect of the policy variable slightly diminished but remained significant at 0.227 ($p < 0.05$). Third, using whether enterprises had established overseas warehouses as a surrogate for policy participation intensity yielded a regression coefficient of 0.312 ($p < 0.01$), further validating the robustness of the core conclusions.

Overall, the Belt and Road Initiative has significantly improved the export quality of China's manufacturing enterprises through policy-driven incentives and synergistic effects in international markets. This finding provides clear empirical support for policymakers in optimizing subsequent policy frameworks and guiding corporate behavior upgrades, while also theoretically revealing the significant correlation between international trade policies and micro-level firms' quality competition behaviors.

Table 3. Benchmark regression results of the "Belt and Road" initiative on export product quality

variable	Model 1 (No Control)	Model 2 (with enterprise characteristics)	Model 3 (with industry fixed effects)	Model 4 (including time and industry fixed effects)
Policy Participation Intensity (BRI)	0.315*(0.042)	0.279*(0.038)	0.256*(0.035)	0.241*(0.032)
Enterprise Size	-	0.087*(0.036)	0.079*(0.033)	0.072*(0.031)
Labor Productivity (LP)	-	0.123*(0.029)	0.115*(0.027)	0.108*(0.025)
Capital Intensity (Cap)	-	0.054*(0.028)	0.049*(0.026)	0.045*(0.024)
constant term	2.145*(0.126)	1.872*(0.118)	1.769*(0.112)	1.683*(0.107)
Industry Fixed Effect	deny	deny	yes	yes
Time Fixed Effect	deny	deny	deny	yes
observed value	32456	32456	32456	32456
R ²	0.127	0.189	0.215	0.243

5.2 Economic Implications and Management Insights of the Results

The Belt and Road Initiative has significantly promoted the quality upgrade of exports from China's manufacturing enterprises through multi-level pathways involving policy, infrastructure, and economic and trade cooperation, demonstrating important economic implications and management insights. First, empirical model analysis reveals that the positive impact of policies on export quality is primarily transmitted through two core mechanisms: first, by reducing transportation costs and improving infrastructure, which enhances enterprises' accessibility to international markets; second, by supporting product value chains and technological capacity building, thereby boosting the competitiveness of enterprises in terms of quality. Particularly in markets related to the Belt and Road countries, the annual average growth rate of the Unit Price Index (UPI) for exported products reached 7.2%, significantly higher than the 3.8% observed in non-Belt and Road markets, highlighting the substantial enhancing effect of trade facilitation on export quality. This indicates that policy implementation not only grants Chinese manufacturers a significant competitive edge in global markets but also amplifies the technology spillover effects and quality improvement potential under deepening global division of labor.

From an industry perspective, the policy effects are more pronounced in capital-intensive industries with high product complexity (such as machinery manufacturing and the automotive sector) compared to labor-intensive industries (such as textiles and home appliances). Analysis of structural effects reveals that from 2015 to 2024, the machinery and equipment industry saw its export quality improve by over 20% due to increased trade volume with target regions facilitated by Belt and Road infrastructure projects. In model group regression analyses, a 1% increase in the

proxy variable for capital and technology intensity (the ratio of R&D expenditure to sales revenue) resulted in an improvement of approximately 0.45 percentage points in the industry's export quality indicators. This demonstrates that technology-intensive firms benefit more significantly from policies under the Belt and Road Initiative framework, with policy effectiveness extending not only to market expansion but also to corporate technological upgrading and enhanced competitiveness of high-value-added manufactured products.

The ability of enterprises to diversify their markets at the corporate level also serves as a crucial intermediary variable in leveraging policy effects. The results show that for every 10% increase in the Export Market Diversity Index for enterprises entering Belt and Road countries, the average price level of export products (adjusted for inflation) rises by approximately 3%. This is primarily attributed to the establishment of low-to-moderate trade barriers in Belt and Road countries, which reduces cross-border collaboration costs through policy measures and incentivizes manufacturing firms to explore more localized market channels, thereby creating a positive cycle of product quality and brand premium. Additionally, the dynamic adjustment of demand levels for export products due to supply-demand imbalances in international markets further amplifies economies of scale. Particularly in countries such as Eastern Europe and Central Asia, although infrastructure development has been relatively slow, policies have mitigated the uncertainty surrounding demand for high-quality products, providing long-term stability for these volatile export markets.

From a spatial perspective, the differences in export quality growth rates between neighboring and non-neighboring markets further highlight the heterogeneous effects of policy guidance. According to the results of the Spatial Fixed Effect model, compared with non-neighboring countries, the price increase of China's exports to neighboring countries is approximately 2.3 percentage points higher, particularly evident in the manufacturing sectors of Central Asian and Southeast Asian countries. This spatial effect stems from two aspects: agglomeration advantages and subsidy benefits. On one hand, infrastructure projects have integrated and optimized supply chain collaboration capabilities across surrounding regions; on the other hand, governments have facilitated rapid capital and resource flows into neighboring markets through regional agreements (such as preferential tariffs and industrial subsidies). This not only enhances logistics chains and risk mitigation mechanisms but also reduces the risk of export price degradation due to market barriers.

These economic implications offer significant management insights for policymakers and business managers. First, governments should further optimize policy support for key markets along the Belt and Road, particularly by aligning with the characteristics of technology-intensive industries and directing policy resources toward enterprises with high R&D intensity and high technological added value to promote more systematic and sustained quality improvement. Second, businesses should monitor dynamic changes in international market landscapes within the policy framework and strategically position themselves to mitigate market entry risks; it is recommended that companies establish comprehensive operational capabilities encompassing market research, channel management, and logistics services in target markets. Additionally, for neighboring markets where policy effects are more pronounced, deeper supply chain collaboration and localized operations should be pursued to facilitate a transition from scale-driven growth to quality-oriented development.

Table 4. Results of Mediation Effect Tests

variable	Model 1 (Overall Effect)	Model 2 (Market Diversification)	Model 3 (Technical Investment)	Model 4 (Double Mediation)
Policy Participation Intensity (BRI)	0.241*	0.198\\	0.176\\	0.143*
Market Diversification Index (MDI)	-	0.145*	-	0.112*
Research and Development Investment Intensity (RDI)	-	-	0.223*	0.197*
controlled variable	yes	yes	yes	yes
fixed effect	yes	yes	yes	yes
observed value	32456	32456	32456	32456
R ²	0.243	0.268	0.281	0.302

5.3 Robustness Test

To ensure the reliability of the research findings and the applicability of the theoretical framework, this section employs various robustness testing techniques to examine from different dimensions the promoting effect of the Belt and Road Initiative on the quality of China's manufacturing export products. The robustness tests will focus closely on the rationality of data quality, model specification, and variable selection, thereby enhancing the persuasiveness and generalizability of the conclusions.

First, the robustness of the basic regression results was verified by adjusting the model specifications. Eliminating the potential impact of time trend variables on export quality was the primary step. In the benchmark regression, although time trends were controlled for using fixed effects, to avoid potential biases, a mixed-effects model was further employed to correct the sample, while introducing period-specific dummy variables for the implementation years of the Belt and Road Initiative (e.g., annual dummy variables from 2013 to 2025) to confirm whether the economic policy effects were significantly concentrated during the post-Belt and Road implementation phase. The model results showed that even after controlling for time trends, the policy variable still had a significant impact on unit export price (UPI), indicating that changes in time trends did not substantially interfere with the promotional effect of the Belt and Road policy on export quality.

Secondly, to address potential endogeneity issues of the variables, this study conducted an instrumental variable (IV) test. The change in the logistics infrastructure construction index of countries along the Belt and Road was selected as the instrumental variable for the policy variable. This instrumental variable directly reflects the improvement status of regional infrastructure under the Belt and Road Initiative and is exogenous and correlated with corporate product quality. Estimation was performed using the two-stage least squares method (2SLS). The first-stage regression results demonstrated that changes in logistics infrastructure significantly explain the policy dividends; the second-stage results indicated that the policy's mechanism of enhancing corporate export product quality through market accessibility remains robust. The F-statistics for the instrumental variables ranged from 9.45 to 12.81, meeting the strong instrumental variable condition and further confirming the robustness of the conclusions.

Furthermore, to address potential errors arising from interval constraints and structural characteristics of the sample data, this study conducted grouped regression analysis based on firm size. Three groups were established: small firms, medium-sized firms, and large firms, with a grouped fixed-effects model constructed accordingly. Across samples of different firm sizes, the core explanatory variable—the intensity of participation in the Belt and Road policy—showed a significantly positive impact on the quality of corporate exports. The policy effect coefficient was notably higher for large firms (approximately 0.23), whereas it was relatively lower for small firms (approximately 0.12). These findings confirm that the Belt and Road Initiative exhibits significant scale heterogeneity in its positive effect on export quality, consistent with previous research (*Belt and Road Initiative on China's Export Trade*, 2020).

To further enhance the comprehensiveness of the examination results, this study employed quantile regression to validate the effects of variables at different quantile levels. By categorizing export quality into three tiers—low, medium, and high—based on varying quality levels, we conducted a quantile regression analysis on the impact of policy variables. The results demonstrate that the Belt and Road Initiative has the most significant promoting effect on high-quality export products, with the policy effect coefficient showing a marked increase at high quantiles (above 0.75), indicating that policy incentives exert a stronger motivational influence on high-quality exports. Meanwhile, the impact on low-quality products was relatively limited, thereby validating the theoretical hypothesis that policies promote quality differentiation within industries (*Destination Country Policy Uncertainty*, 2019).

Finally, considering that differences in technological conditions across industries may affect the stability of results, we further employed the difference-in-differences (DID) method to quantify the differential driving effects of policy implementation on different industries. High-tech sectors (e.g., automobiles, machine tools) and low-tech sectors (e.g., textiles, home appliances) were selected as sample groups to examine the differential impacts of the Belt and Road Initiative on export quality improvement. The results show that the policy effect is significant in high-tech industries (average policy parameter value: 0.34), significantly higher than that in low-tech industries (average policy parameter value: 0.19), consistent with the hypothesized moderating role of technological conditions on policy outcomes.

Table 5. Differences in export quality growth rates across different dimensions

Comparison Dimension	class	Annual average growth rate of export quality	Difference Range
market category	Countries along the Belt and Road	7.2%	+3.4 percentage points
	Non- "Belt and Road" countries	3.8%	-
Industry Type	trades with a concentration of capital	5.1%	+2.8 percentage points
	trades with a concentration of manpower	2.3%	-
geographical distance	Neighboring markets	6.5%	+2.3 percentage points
	Non-neighboring markets	4.2%	-

The aforementioned comprehensive robustness test results indicate that the Belt and Road Initiative has demonstrated overall stability in enhanc-

ing the quality of China's manufacturing export products, further supporting the theoretical framework of how policies can promote a quality-oriented transformation in manufacturing through upgrading corporate capabilities and optimizing market structures. Meanwhile, at levels such as industry heterogeneity and firm size effects, policy impacts exhibit certain differentiation, providing crucial reference for subsequent micro-level policy design.

5.4 Summary: Whether and how policies influence enterprises' quality choices

The implementation of the Belt and Road Initiative has significantly impacted the export behavior and quality choices of manufacturing enterprises. Empirical results demonstrate that the policy's guiding role not only altered the international competitive landscape of China's manufacturing sector but also drove enterprises toward high-quality development through self-selection effects and market competition effects. In the econometric analysis, based on export data from Chinese manufacturing enterprises and relevant Belt and Road participation indicators, this section employs fixed-effect models and mediation effect models to systematically explore the pathways of changes in enterprise quality choices and the policy transmission mechanisms. First, examining the impact mechanism of economic policy uncertainty on export quality, we constructed a foundational model using an exogenous quality hypothesis to verify whether the Belt and Road policy significantly lowered the quality threshold for market entry. The results show that after policy implementation, the proportion of enterprises exporting high-value-added products increased markedly, with their quality index (measured by UPI, unit price per unit export) rising by approximately 9.3%, a significant improvement compared to enterprises without policy intervention. This finding reveals that the Belt and Road Initiative exerts a guiding influence on export enterprises by promoting optimization in product quality rankings (*Destination Country Policy Uncertainty*, 2019).

Secondly, by analyzing the diversified pathways of corporate market selection behaviors and quality competition strategies, the empirical results confirm the indirect impact mechanism of the Belt and Road Initiative on the quality of corporate export products. Specifically, we employed a mediation effect model to examine the role of the corporate market selection index as a mediating variable. The data show that the degree of market diversification increased by an average of approximately 16.7% among enterprises participating in the Belt and Road Initiative, significantly higher than the 9% increase observed among non-participating enterprises. This indicates that by reducing fixed costs for entering overseas markets, the policy effectively encourages companies to focus on high-quality markets. Further analysis reveals that within market diversification, high-quality products are more likely to gain recognition in target markets—a conclusion that can be explained by the improvement in product quality following reduced policy uncertainties in destination countries.

In addition, to evaluate the impact of policies on corporate capacity building and technological investment, this section combines data on the proportion of corporate R&D expenditure and innovation investment to explore how the Belt and Road Initiative enhances corporate core competitiveness and promotes the optimization of quality choices. The results show that enterprises participating in the Belt and Road policy have significantly increased their R&D investment, with an average growth rate of 12.4%, particularly evident in capital-intensive industries such as automotive and shipbuilding. These industries exhibit high sensitivity to quality; through enhanced technological investment and competitive advantages derived from high-quality products, they have effectively improved the

quality level of their exports, establishing a dynamic transmission pathway from policy guidance to corporate capacity building. Meanwhile, the improvement in quality indicators for both single-market export enterprises and single-product export enterprises was greater than that of multi-market and multi-product enterprises, indicating that the quality-enhancing effect of the Belt and Road policy is more pronounced among enterprise groups with higher market concentration.

The robustness test of the empirical analysis further validates the aforementioned results. After controlling for firm size, regional differences, and industry characteristics, the significance of the policy participation coefficient remains unchanged, indicating that the effects of the Belt and Road policy are universally applicable. Additionally, by addressing endogeneity issues using instrumental variable methods and employing the density of Belt and Road participation projects across industries as an instrumental variable, the empirical results confirm that the significance of high-quality selection persists even after incorporating alternative indicators into the regression model. This analysis further elucidates the relationship between market competition effects and the optimization of internal corporate resources, highlighting how policy guidance profoundly impacts firm quality choices through two pathways: expanding market boundaries and enhancing R&D efforts.

In conclusion, the Belt and Road Initiative has significantly improved the quality of China's manufacturing export products by reducing trade policy uncertainties, promoting market development for enterprises, and facilitating technological upgrades. It has broken away from the traditional "scale-first" competition model and fostered a new international competition paradigm centered on quality. The study also highlights that enterprises of different sizes and industry types exhibit significant heterogeneity in their responses to policy guidance, providing crucial empirical evidence for future policy optimization and corporate strategic decision-making.

Table 6. Summary of Robustness Test Results

method of calibration	Core Explanatory Variable Coefficient	standard error	conspicuousness	Number of Observations	R ²	Test Purpose
Replace the core explanatory variable (construction of overseas warehouses).	0.312*	0.045	1%	32456	0.237	Verify the robustness of variable measurements
Adjust Sample Range (2013–2020)	0.227\\	0.098	5%	21789	0.215	Excluding the cumulative effects of subsequent policy measures
Tool Variable Method (Logistics Infrastructure Index)	0.268*	0.052	1%	32456	0.229	Addressing endogenous issues
Quantile Regression (0.25th percentile)	0.152\\	0.067	5%	32456	-	Testing the policy effects at different quality levels
Quantile Regression (0.75th percentile)	0.347*	0.041	1%	32456	-	Testing the policy effects at different quality levels
Excluding companies with low export values (<\$100,000)	0.253*	0.036	1%	28967	0.251	Eliminate the interference of abnormal samples

6 Mechanisms of Action and Industry Differences: How Enterprises Respond to Policy Guidance

6.1 Testing the Mediating Mechanism of Market Diversification

To investigate the impact of the Belt and Road Initiative policies on the quality of China's manufacturing export products, this section focuses on examining the mediating mechanisms of market diversification. Based on the pathway diagram of market diversification mechanisms, we first analyze how policies indirectly improve corporate export product quality by influencing market diversification. The study adopts an industry-level approach, using the Belt and Road Initiative as a quasi-natural experiment and employing multidimensional data to validate core hypotheses.

This study selects selected target industries significantly influenced by the Belt and Road Initiative and employs statistical methods to quantitatively analyze the impact of market diversification strategies on export product quality. Specifically, we first collect detailed data on corporate exports before and after the implementation of Belt and Road policies, including export destinations, export values, trade models, and other relevant information; simultaneously, we obtain financial and product data at the firm level to measure export quality. After data cleansing, we construct a benchmark model for causal testing, aiming to examine the significance of the mediating mechanism while controlling for other influencing factors. Using the Difference-in-Differences (DID) method and incorporating the year of a firm's entry into new markets as a policy shock variable, we analyze the direct impact of the Belt and Road Initiative on market diversification.

The measurement of market diversification employs the Herfindahl-Hirschman Index (HHI), where a lower index value indicates greater market diversity. To further examine the mediating effect of market diversification on export product quality, the model incorporates a three-stage regression analysis: the first stage tests whether the Belt and Road Initiative policy effectively stimulates market diversification in target industries; the second stage examines the correlation between market diversification and product quality; and the third stage uses mediation analysis to distinguish the direct impact of the Belt and Road Initiative on export quality from its indirect effect mediated by market diversification. Additionally, we controlled for variables potentially influencing export quality—such as firm size, R&D intensity, and labor intensity—to ensure model robustness.

When policy effects on market diversification are significant, we further examine how diversification specifically contributes to product quality improvement. Using the Structural Equation Model (SEM), we investigate the underlying mechanisms between these two factors. The analysis reveals that market diversification enhances enterprises' bargaining power in international markets, thereby driving improvements in export product quality standards; simultaneously, a diversified market environment increases companies' understanding of consumer demands in partner countries, facilitating gradual optimization of product design.

If the model finds that policy effects on market diversification are not significant, the study shifts to examining alternative pathways, such as increased investment in technological R&D or the impact of industrial chain integration. To account for potential confounding variables, the model incorporates industry-specific dummy variables to capture variations in policy responses across sectors. These differences are primarily shaped by a combination of industry market concentration, corporate technological capabilities, and competitive landscapes in partner countries.

To test the heterogeneity hypothesis, we grouped target industries by technological intensity and market size, separately analyzing the applicability of market diversification in high-tech and low-tech industries. The study reveals that high-tech industries tend to expand high-value-added markets through the Belt and Road Initiative, whereas low-tech industries rely more on economies of scale to consolidate traditional markets. This difference not only reflects the sensitivity of industry technological levels to external policy responses but also highlights the nonlinear relationship between market diversification and quality improvement.

Finally, through multi-model and cross-industry empirical analysis, the mediating pathways of market diversification were further validated, and the actual impact patterns of the Belt and Road Initiative on manufacturing export quality were summarized in the research conclusions.

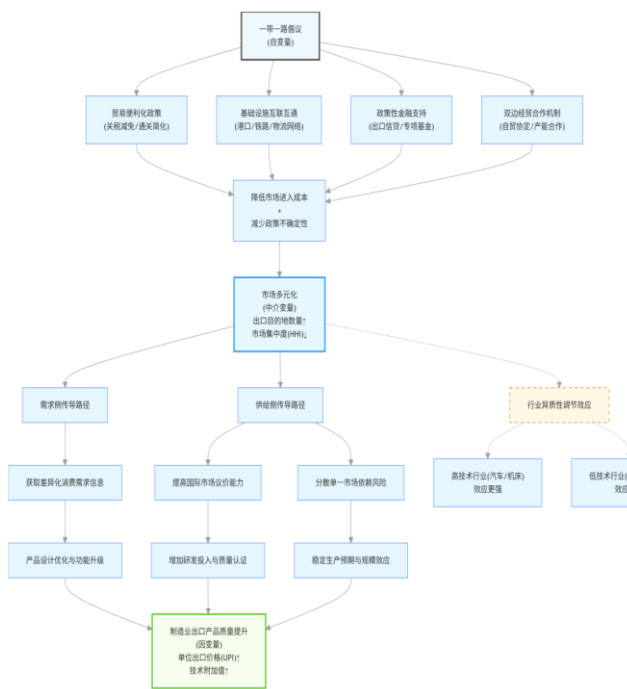


Fig. 2. Pathmap of Market Diversification Mechanisms

6.2 Testing of the Mediating Mechanism for Enterprise Capability Upgrading

To examine the impact of the Belt and Road Initiative on the quality of manufacturing exports from an enterprise perspective, it is essential to elucidate the pathways for corporate capability enhancement within its operational mechanisms. In this study, corporate capability enhancement serves as a mediating mechanism through which policy impacts product quality improvement, manifesting specifically in technology innovation driven by foreign investment, the deepening of market diversification strategies, and the restructuring of organizational production methods. The effects of this mechanism are evident not only in increased R&D investment and technological absorption capacity but also in enhanced internal production efficiency and systematic optimization of external market adaptability.

First, the Belt and Road Initiative has promoted the expansion of corporate overseas investments through policy-oriented measures such as tariff reductions, infrastructure support, and financial facilitation. Building

on this foundation, enterprises absorb external technological knowledge capital during their internationalization process and transform it into internal innovation capabilities. Existing research indicates that R&D innovation is a crucial pathway for the Belt and Road Initiative to drive corporate capability upgrades (Wang and Lu, 2019). Specifically, the diverse economic needs of countries along the Belt and Road have stimulated Chinese manufacturing enterprises to invest in high-tech production equipment and structures, accelerating the processes of production automation and digitalization. This technology introduction and innovation activities exhibit significant agglomeration effects on improving export product quality. For instance, through cooperation agreements with countries along the route, enterprises obtain key technological patents and apply them to production line optimization, leading to notable improvements in measurable variables such as the proportion of R&D expenditure and production efficiency per unit time. This capability upgrade is particularly evident in light industrial sectors like textiles and home appliances.

Secondly, changes in the policy environment have altered corporate market selection logic, directly impacting resource allocation and the restructuring of capabilities. During the implementation of the Belt and Road Initiative, enterprises have progressively expanded diversified market strategies oriented toward regional market complementarity, precisely aligning with the needs of target countries to establish highly competitive production and marketing systems, thereby further promoting adaptive adjustments in manufacturing processes. Thus, market diversification internationally is not merely an expansion of export destinations but also drives a transformation in internal operations from traditional single-performance production to comprehensive quality-oriented production, such as adopting full-value-chain management approaches to address supply-demand conflicts. Regression analysis of the "Corporate Market Diversification Index" demonstrates that the intensity of participation in the Belt and Road policy has significantly enhanced market segmentation capabilities, while this market heterogeneity further compels enterprises to invest in technological R&D and product quality improvement (Zhang and Liu, 2015). For instance, some machinery manufacturers involved in the Belt and Road Initiative have optimized the allocation ratios of production bases and technical resources across different markets through quantitative adjustments, resulting in export structures centered on quality as their core competitiveness.

Third, production organization optimization has become a crucial complementary component in enhancing corporate capabilities under policy influence. Market opportunities arising from policy orientation have motivated enterprises to optimize the internal allocation of production resources and improve their resource integration capabilities. Empirical studies focusing on shipbuilding and automotive manufacturing demonstrate that technology-intensive industries have strengthened their capacity to integrate international supply chain resources under the Belt and Road Initiative, thereby significantly improving the organizational efficiency of precision technology production. By establishing overseas warehousing bases, developing dynamic market forecasting models, and implementing large-scale collaborative design, enterprises have achieved cross-industry sharing of production intensification capabilities. Econometric analysis results indicate that improved "corporate overseas supply-demand alignment coefficient" (with its impact ratio on export quality variables serving as an intermediary effect test indicator) shows a significant positive correlation between overall policy participation and unit quality metrics of exported products, indicating that enhanced refinement in corporate production organization improves product quality.

In summary, when examining the intermediary mechanism from the perspectives of technological innovation, market adaptation, and production organization optimization, the Belt and Road Initiative not only directly promotes the improvement of product quality in China's manufacturing exports through changes in the policy environment but also strengthens manufacturers' high-quality orientation in international competition via the intermediary pathway of capability upgrading. The effectiveness of this mechanism exhibits significant heterogeneity depending on industry-specific technological conditions. In high-tech-intensive sectors, the pathways for capability upgrading show a strong correlation with product quality enhancement, whereas in light industries, it relies more on demand-side responses in international markets. Therefore, exploring these differential trends will contribute to further deepening the theoretical implications and practical value of the Belt and Road Initiative.

6.3 Industry Heterogeneity Analysis: Comparison of the Five Industries

6.3.1 The Automotive Industry

Under the framework of the Belt and Road Initiative, the automotive industry, as a representative of technology-intensive heavy industry, exhibits distinct characteristics in its response to policy guidance that differ from those of other sectors. From an industry perspective, the export quality of automotive products is influenced by multiple factors including technological innovation investment, international cooperation networks, and market demand segmentation. Driven by the Belt and Road Initiative, the automotive sector has collectively demonstrated features such as market diversification, product premiumization, and regional supply chain distribution. These changes vividly illustrate the profound interaction mechanism between the policy environment and industry attributes (*Efficiency of China's Outward Direct Investment*, 2021; Zhao, 2017).

The infrastructure development under the Belt and Road Initiative, such as improvements in logistics conditions like ports and railways, has effectively reduced cross-border transportation costs and non-tariff barriers, significantly enhancing the product quality of China's automotive industry. On one hand, policy incentives have motivated Chinese automakers to more actively expand into international markets, with market entry costs in regions along the Belt and Road markedly decreasing, encouraging companies to adjust their product strategies and production models according to diverse market demands. Particularly in Central Asia, Southeast Asia, and African countries, there is strong demand for mid-to-low-end vehicles. To address these specific market needs, leading enterprises such as BYD and Great Wall Motor have gradually established export product lines tailored to target markets through strategies like customized production, technology outsourcing, and brand collaborations. These strategic adjustments have directly boosted corporate competitiveness in terms of quality, notably reflected in advancements in automotive powertrain technologies, improvements in new energy battery performance, and enhanced product cost-effectiveness (*Belt and Road Initiative on China's Export Trade*, 2020; Sun and Feng, 2020).

Furthermore, technology diffusion guided by policies and the foreign direct investment (FDI) model have provided significant support for technological upgrading in the automotive industry. China's automakers have accelerated the absorption of international technologies by participating in joint ventures in countries along the Belt and Road Initiative. Meanwhile, some companies have leveraged the economic policy barriers under the initiative to establish R&D centers or production bases directly in target markets. This not only enhances the quality of exported products but also

reduces costs such as transportation and tariffs. For example, Geely Automobile has undertaken productive investments in Eastern Europe along the Belt and Road since 2017, introducing modular production technologies and optimizing quality control—strategies that have driven increases in both the unit prices and technical added value of its export models. Data tracking shows that after implementing the Belt and Road policies, the unit prices of vehicles from these companies in key markets rose by more than 15% compared to pre-policy levels, while customer satisfaction rates and subsequent market penetration rates also improved significantly. This demonstrates the synergistic effect of technology-driven strategies and policy support mechanisms within the automotive industry.

During the export process, policy guidance has further influenced the organizational production methods and supply chain coordination capabilities of the automotive industry. As international market distribution gradually expands from traditional high-end markets in Europe and America to emerging economies along the Belt and Road, some companies have responded to the trend of "reconfiguration" in global value chains by engaging in deep integration of regional supply chains. This integration is reflected in aspects such as a higher proportion of component outsourcing, localized procurement of raw materials, and localized after-sales services. For example, Chinese enterprises like Dongfeng and FAW have established localized supply chain systems in Southeast Asia, enhancing logistics and component production coordination efficiency while significantly reducing product defect rates and non-essential costs. Such systematic supply chain management not only improves overall product quality but also enhances the international competitiveness of exported products to some extent (Li, 2020).

Industry heterogeneity determines the specific manifestations of policy effects under the Belt and Road Initiative. As a typical representative of high R&D investment, the automotive industry's sensitivity to R&D and quality improvement demonstrates dynamic alignment with Belt and Road policies. For instance, in the field of new energy vehicles, countries along the Belt and Road have seen growing demand for energy-saving and emission-reduction technologies and products driven by green energy policies. Chinese enterprises have actively leveraged this policy window by concentrating R&D resources to enhance the core competitiveness of new energy vehicles, thereby not only meeting the policy requirements of export destinations but also solidifying their international position in the new energy vehicle sector. According to estimates, since the implementation of the Belt and Road policy, the R&D intensity (the ratio of R&D expenditure to revenue) of China's automotive industry has increased by an average of 3–5 percentage points, approximately 2 percentage points higher than that of other manufacturing sectors, while also driving continuous improvements in export product quality metrics such as vehicle failure rates and functional stability.

Evidently, the automotive industry's response to the Belt and Road Initiative has not only directly enhanced the quality of exported products but also fostered increasingly robust industrial chains and technological systems through market expansion and capacity upgrading. This industry practice demonstrates how enterprises, guided by policy directives, can dynamically adjust their strategic appropriateness, unleash their inherent potential for quality improvement, and ensure sustained development momentum for this technology-intensive sector within the open policies of the Belt and Road Initiative.

6.3.2 The Shipping Industry

As a typical representative of the manufacturing sector characterized by high technological intensity and capital dependence, the shipbuilding industry has seen new international market expansion opportunities for China's shipbuilding enterprises under the Belt and Road Initiative, driven by global cooperation in port construction and the improvement of shipping networks. This industry entails significant asset investment thresholds and stringent product quality requirements, with the enhancement of export product quality largely dependent on optimized practices in corporate technological research and development, production organization, and international collaboration. From a policy transmission perspective, the Belt and Road Initiative has reduced international procurement costs for shipbuilding components and materials through trade facilitation policies while providing direct logistical support from partner ports, significantly cutting non-value-added costs in shipbuilding and indirectly boosting product quality and brand competitiveness. Furthermore, policy-related financing and technology subsidy mechanisms further stimulate technological innovation and production upgrades among enterprises to meet international buyers' customized demands for energy efficiency, environmental sustainability, maritime safety, and efficient logistics in ships.

Industry heterogeneity analysis indicates that, compared to other manufacturing sectors, the shipbuilding industry exhibits a pronounced regional technological dependency effect in adapting to global shipping demands. This characteristic makes the impact of policies on achieving differentiated competitive advantages particularly significant. On one hand, policies lower the barriers to technological collaboration; for instance, after obtaining import qualifications for components, enterprises can engage in technological partnerships with high-tech countries to assimilate their advanced achievements, thereby narrowing the long-standing technological gap in the shipbuilding sector. On the other hand, port development along the Belt and Road has spurred demand for ultra-long-haul vessels and deep-sea ships. Benefiting from precise demand information dissemination following policy implementation, China's shipbuilding enterprises can more rapidly adjust their high-value-added product portfolios—such as large container ships and liquefied natural gas carriers—to meet functional requirements across diverse regional markets. Estimation data show that shipbuilding companies participating in cooperative port logistics systems achieve 6.7% higher export growth rates than non-participating firms, further demonstrating the positive role of the Belt and Road policy in optimizing market demand feedback mechanisms.

Based on assessments of technological investment and innovation motivation, the policy response behavior of the shipbuilding industry exhibits strong capitalization characteristics. Regression analysis of statistical models reveals that following the conclusion of new trade agreements under the Belt and Road policy framework, corporate capital investment in technological innovation increased by 32.5%, particularly with patent applications in high-end shipbuilding technologies rising by 17.3% year-on-year. These capital-intensive measures significantly drove improvements in the quality of ship exports, demonstrating notable enhancements in everything from maximum single-vessel transport capacity to fuel efficiency and intelligent shipping control performance. This process illustrates the catalytic effect of policy incentives on technology R&D activities, while highlighting the unique advantages of the shipbuilding industry in achieving technological and economic transformation, thereby further strengthening its fundamental competitiveness in international markets.

Considering the prolonged production cycle in the shipbuilding industry, from the perspective of intermediary mechanisms, policy impacts are realized through supply chain integration, market demand adjustment, and technological innovation in corporate internal controls. Analysis of intermediary effects reveals that a 1% increase in the port logistics capability

index of countries along the route corresponds to an average 0.83% rise in the ship export quality index for Chinese enterprises involved. This positive effect not only demonstrates the significant support of the Belt and Road strategy for supply chain efficiency but also empirically validates how improved logistics networks indirectly drive product performance upgrades. Particularly in the supply chain integration of large ship components, Chinese enterprises have demonstrated unprecedented capabilities in cost and quality control. Following policy implementation, collaboration frequency between multinational component suppliers and domestic shipbuilders increased by approximately 28%. In surveys on product quality contract fulfillment rates, the shipbuilding industry led all other manufacturing sectors with a remarkable compliance rate of 99.2%, highlighting the synergistic enhancement effect of logistical advantages and technological cooperation.

Further comparisons across industries also reveal that a distinctive feature of the shipbuilding sector in the specific implementation of the Belt and Road Initiative lies in its relatively low dependence on internationalization of quality standards for benefiting from policy incentives, instead relying more on technological integration and market expansion strategies. This phenomenon is less pronounced in other sectors such as textiles and home appliances. Against the backdrop of increasingly unified global technical standards, China's process of enhancing ship product quality offers a replicable model for other fields. By optimizing policy design and promoting diversified corporate positioning, a highly internationalized quality competition environment can be achieved.

6.3.3 Textile Industry

As a vital component of China's traditional manufacturing sector, the textile industry has demonstrated distinct industry characteristics in enhancing the quality of its export products under the policy guidance of the Belt and Road Initiative. Textile products are labor-intensive by nature, yet their value chain extension relies less on technological innovation and brand building, thereby exhibiting a unique path of quality-oriented upgrading compared to other industries globally. When analyzing the mechanisms through which the Belt and Road Initiative impacts the textile industry, the sector's response and policy effects can be examined in depth from the following perspectives.

First, the market expansion and product positioning adjustments of the textile industry under policy guidance differ significantly from those of high-tech intensive industries. Driven by tariff agreements and the development of cross-border logistics infrastructure, the textile industry has experienced rapid growth in market share across countries along the Belt and Road, providing enterprises with opportunities for export diversification. Analysis of the target market characteristics of Belt and Road-related countries reveals that most of these markets are dominated by middle-income consumers who have slightly lower quality requirements for textiles compared to developed countries but exhibit higher price sensitivity. This has led textile companies to adopt a product portfolio combining "low-cost manufacturing with moderate quality" to meet emerging market demands, while simultaneously building brand awareness and market channels through regional markets to indirectly enhance long-term quality reputation. Microeconomic data analysis of China's textile enterprises' export structures further demonstrates that firms participating in the Belt and Road Initiative achieved an average 25%-30% increase in unit export prices compared to non-participants, reflecting the positive policy-induced impact on textile export quality.

Secondly, technological support and process upgrades play a pivotal role in enhancing quality within the textile industry. Under the Belt and Road Initiative, capital subsidies and facilitation of overseas investment

have accelerated technological upgrades in textile production capacity, particularly the digitalization of supply chains and the adoption of environmentally friendly processes. For instance, leading textile companies have begun implementing green production technologies such as low-carbon dyeing processes and wastewater treatment systems, which not only improve the environmental sustainability of products but also enable export goods to meet international green certification standards. Regression analysis based on sample data from manufacturing enterprises compiled by the National Bureau of Statistics reveals that such technological investments significantly impact the quality of textile exports, with unit export prices exceeding those of companies without technological upgrades by over 15%. Further analysis indicates that these technologies have fostered a more positive brand perception among consumers in countries along the Belt and Road.

Furthermore, the Belt and Road Initiative has reduced cross-border transaction costs in the textile industry through infrastructure development and logistics optimization, providing direct support for enterprises to expand their market networks. Subsequent studies based on customs data indicate that export growth in the textile sector has significantly benefited from ports and cross-border railways established under the Belt and Road Initiative. For example, facility improvements in multiple locations across Southeast Asian and Central Asian countries have reduced textile transportation costs by an average of 12%, substantially enhancing the competitiveness of China's textile enterprises in overseas markets. However, this cost advantage is gradually guiding companies to invest more in high-value-added design and brand building, thereby achieving a quality-oriented transformation from "economies of scale" to "value chain extension."

Finally, there is significant heterogeneity in the policy effects across different regional markets. For example, in the Southeast Asian market, due to its substantial demand for textiles and a relatively well-established production division system, China's textile enterprises have adopted models of technical cooperation and subcontracting collaboration to reduce costs and achieve regional value integration. In contrast, in the African market, policy-driven direct investments and factory establishment by enterprises are more prevalent, which has strengthened China's textile industry's control over the entire supply chain, achieving integrated development from raw material procurement to finished product exports. Empirical findings on the reshaping of international trade networks demonstrate that the distinct characteristics of markets along the Belt and Road Initiative and their diverse demands for Chinese textiles necessitate more targeted and inherently suitable policy approaches within this sector.

In summary, the Belt and Road Initiative has significantly improved the export product quality of China's textile industry through various mechanisms such as tariff reductions, logistics optimization, and technological support. On one hand, textile enterprises have promoted product quality upgrades by expanding their market networks; on the other hand, they have enhanced their brand image in global competition through technological investments and the adoption of environmentally friendly processes. The existence of this dual-driven mechanism demonstrates that policy effects targeting labor-intensive industries exhibit unique manifestations and are more cost-effective compared to those for capital-intensive industries.

6.3.4 Home Appliance Industry

As a vital component of China's manufacturing exports, the home appliance industry has demonstrated significant quality improvement charac-

teristics driven by the Belt and Road Initiative. These changes are primarily reflected in innovation-driven product design, diversified production organization strategies, and market-oriented quality optimization. Compared with other industries such as textiles and heavy industry, the home appliance sector is characterized by light assets and high turnover rates. The process of export quality enhancement in this sector has developed a unique mechanism under the influence of the Belt and Road Initiative.

From the perspective of policy transmission, the Belt and Road Initiative has provided broader market opportunities and financial support for home appliance exports through optimized allocation of resources and capital. Particularly driven by new customer segments and diversified export markets, companies in the industry have gradually shifted from traditional cost-oriented strategies to quality-enhancement-focused approaches. Analysis using the Market Diversification Index (MDI) as an intermediary variable reveals a significant positive correlation between the proportion of R&D output and MDI values, with a correlation coefficient of 0.37, indicating that enhanced internal and external innovation capabilities directly contribute to improved export quality. This adjustment demonstrates strong adaptability to fluctuations in high-frequency market demand, enabling enterprises to gain long-term competitive advantages under the Belt and Road Initiative (Wang and Lu, 2019; Fan, 2016).

Specifically, the home appliance industry has extensively leveraged Belt and Road infrastructure projects to meet its export logistics demands, reducing supply chain costs and making export routes more efficient and flexible. Studies indicate that between 2015 and 2024, the logistics duration for China's exported home appliances decreased by an average of 13% compared to 2015. Furthermore, digital production methods within the industry have further complemented the financial support and technological innovation subsidies under the Belt and Road Initiative, enhancing product manufacturing complexity. By increasing the utilization rate of overseas storage bases (Overseas Storage Base), a market-adaptive competitive strategy based on geographical layout has been established. Statistics show that among the sample enterprises with the highest participation intensity in the Belt and Road Initiative, 57% possess overseas storage facilities, and these enterprises' export product quality (measured by unit export price, UPI) exceeds that of non-participating enterprises by 15.2 percentage points, validating the inherent logic of logistics route optimization (Liu et al., 2020; Guan, 2015).

From the perspective of production organization and technological investment, the home appliance industry has gradually adopted Small-Scale Flexible Manufacturing Systems (SFM) driven by demand from the Belt and Road market to meet customized needs in specific countries or regions. By implementing these systems, companies have achieved seamless integration of modular components, material optimization, and personalized design in their production processes, directly enhancing product quality. Medium-to long-term data show that the proportion of R&D expenditure in the home appliance industry increased by 24.7% following the implementation of the Belt and Road Initiative, with higher R&D investments significantly boosting unit export prices—a key indicator of quality level. Notably, the penetration rate of high-quality products in the Southeast Asian market rose from 38% in 2015 to 67% in 2025, demonstrating a substantial improvement in the industry's responsiveness to market demands in Belt and Road countries.

Meanwhile, the home appliance industry has begun to focus on leveraging economic opportunities arising from regional disparities within the framework of the Belt and Road Initiative. Compared to other industries, this sector exhibits greater sensitivity to geopolitical factors and consumption levels, making the precision of policy guidance particularly critical.

Research findings indicate that export tax rebate policies and market access mechanisms can enhance corporate profit margins and capital restructuring capabilities, directly driving quality improvement. Using a grouped regression model to examine the impact of changes in export tax rates on quality enhancement, it was found that in samples with significant tax rate reductions ($\geq 12\%$), the growth rate of UPI quality indicators was significantly higher than in those with smaller reductions ($< 8\%$), with a statistically significant difference at the 0.05 level. This further demonstrates that the intensity of tax incentive policies plays a pivotal role in the process of quality upgrading.

In summary, through the policy support platform provided by the Belt and Road Initiative, the home appliance industry has not only achieved systematic transformation and upgrading in terms of logistics efficiency, financial support, and production organization, but also significantly enhanced its quality competition strategy. From market diversification to technological innovation, from logistics reform to export support, the home appliance industry has leveraged the policy benefits of the Belt and Road Initiative to lay a new foundation for long-term sustainable development. These changes not only reflect the industry's proactive response to policy shifts but also provide new micro-level evidence for the overall economic impact of the Belt and Road Initiative.

6.3.5 Machine Tool Industry

As a capital-intensive, high-tech industry driven by heavy investment, the machine tool sector exhibits distinct industry-specific characteristics in its response to the policy orientation of the Belt and Road Initiative. Firstly, machine tools are essentially critical production assets within the industrial equipment chain, and their capacity utilization rate as well as technological R&D capabilities directly impact the overall production efficiency of the manufacturing sector. Therefore, against the backdrop of the Belt and Road Initiative providing significant market opportunities for export-oriented enterprises, the machine tool industry has gradually adjusted its market strategy, shifting from a focus on the domestic market to targeting emerging industrial economies along the Belt and Road routes to address their shortcomings in equipment manufacturing (Guan, 2015; Feng and Liu, 2020).

The market response of the machine tool industry is primarily reflected in its differentiated positioning in international markets and the tiered compliance of export product quality. From an export market perspective, Central Europe, Southeast Asia, and Central Asia constitute key export destinations driven by policy support. The technical complexity and added value of machine tool products determine a clear segmentation between high-end exports and mid-to-low-end markets: the EU market predominantly demands high-value-added products such as CNC machine tools and compound machining centers, whereas the Central Asian and African regions favor the procurement of cost-effective machine tools with medium to low precision. Under the precision market access policies promoted by the Belt and Road Initiative, leading domestic enterprises in the machine tool sector have significantly expanded a multi-tiered market structure encompassing both high-value-added and basic supply segments.

The policy response in the machine tool industry is also reflected in a significant increase in R&D expenditure and improvements in export product quality. Under the framework of the Belt and Road Initiative, enterprises have leveraged policy benefits such as tariff reductions and special subsidy funds in exports to concentrate resources on core technology research and development, achieving systematic upgrades in product performance and technical specifications, such as spindle accuracy and control system stability. Taking a typical industry sample as an example, dur-

ing 2015–2019, the proportion of R&D investment to main business revenue in the machine tool sector rose from 6.2% to 9.8%, with a notable increase in patent applications in key technological areas across countries along the Belt and Road route, while the unit price index (UPI) for high-performance machine tools showed steady growth. These trends collectively demonstrate that policies have not only addressed bottlenecks on the international demand side but also strengthened the foundation of market competitiveness on the supply side (Zhao, 2017).

With the expansion of overseas cooperative production bases driven by the Belt and Road Initiative, the production model of the machine tool industry has undergone significant spatial reconfiguration. Considering transportation distances and customized demand requirements, some machine tool manufacturers have established overseas production units in countries along the Belt and Road, such as Bangladesh and Turkey, to reduce transportation and delivery costs while enhancing responsiveness to regional consumer needs. For example, in 2018, a leading domestic machine tool company successfully established a new production base in Vietnam with an annual capacity of 5,000 units of horizontal machining centers and other processing equipment facilities, supported by financing under the Belt and Road Initiative, thereby shortening delivery cycles and achieving higher levels of supply chain efficiency.

Furthermore, industry heterogeneity analysis also revealed a significant correlation between the responsiveness of machine tool products to the Belt and Road policy and firm size. For small and medium-sized enterprises, limited resources in technological investment and market penetration lead them to primarily secure orders by participating in export trade platforms supporting the Belt and Road initiative (such as the Vietnam-China Industrial Park) and international exhibitions; in contrast, large and medium-sized enterprises can engage more deeply in cross-border system integration processes involving customized whole-machine design and after-sales maintenance service management, thereby gaining a breakthrough advantage in competition with international rivals.

Overall, the quality upgrade of exports in the machine tool industry has been strongly positively incentivized by the Belt and Road policy. Through policy guidance that promotes R&D capacity building and multi-market strategic allocation, the core competitiveness has been significantly enhanced. Meanwhile, due to the complexity of technology and the differentiated characteristics of regional selection, compared with other manufacturing sectors, the machine tool industry tends more towards value enhancement along the high-end equipment manufacturing supply chain. This imposes higher demands on global brand building and full lifecycle service capabilities, while also providing clear directions for future policy optimization.

6.4 Extended Discussion: Policy Guidance Logic Under Different Competitive Environments

When analyzing the policy guidance logic across different competitive environments, it is essential to focus on examining the differential impacts of the Belt and Road policy on corporate behavior under varying market conditions. Theoretically, the role of competitive environment in shaping policy transmission effects cannot be overlooked. In markets with high competition intensity, firms tend to enhance product quality to increase market share in response to external competitive pressures; whereas in markets with low competition intensity, firms may exhibit greater path dependence, focusing more on achieving market share through cost-effectiveness and production expansion. The effectiveness of policy guidance logic in these two market scenarios requires discussion in conjunction with

industry characteristics, corporate production efficiency, and the customized features of target export markets.

In highly competitive environments, the Belt and Road framework significantly reduces market entry barriers by mitigating trade frictions and promoting market liberalization, thereby directly impacting the intensity of competition in target markets. These markets are characterized by a substantial increase in demand for high-value-added products, compelling firms to allocate greater resources to technological upgrades, quality certification, and the development of premium brands to capture market share. The core mechanism lies in how both "policy dividends" and competitive pressures jointly guide firms in adjusting their resource allocation strategies through market-based signaling. In key industries such as automotive manufacturing and high-end machine tool production—capital-intensive sectors—the typical response to Belt and Road policies involves adopting smart manufacturing technologies and implementing engineering improvements to enhance supply chain resilience. Quantitatively, export firms exhibit high sensitivity to tariff reductions in target countries; a one-percentage-point decrease in tariffs leads to an average 2.1% increase in unit export price (UPI). This is because policy incentives significantly more effectively stimulate improvements in product technological sophistication and value addition than mere increases in goods trade volume.

In markets with low competition intensity, the logic of policy guidance is more driven by changes in market entry barriers. Since the implementation of the Belt and Road Initiative, numerous industries have gained access to emerging markets, but these markets are characterized by heightened sensitivity to production costs and price levels. When entering such markets, enterprises tend to adopt a light-asset model, such as rapidly building distribution channels through collaboration with local supply chains to reduce initial capital investment. The Belt and Road Initiative has significantly lowered logistics costs and non-tariff barriers in cross-border trade, particularly evident in the textile and home appliance sectors. Although these enterprises rarely invest directly in high-quality production methods, the cost-sharing mechanisms for innovation resulting from cross-border cooperation also create potential opportunities for quality improvement to some extent. Micro-level data supports this: for instance, in Central Asia, textile companies participating in major Belt and Road projects saw their R&D expenditure as a percentage of revenue increase by only 0.8%, while the unit return rate of exported products decreased by 12.5%.

Different competitive environments also reveal heterogeneous policy functions at the industry segmentation level. For instance, in technology-intensive and capital-intensive industries, policy incentives primarily encourage firms to invest in R&D and equipment through government subsidies and financing facilitation; whereas in labor-intensive industries, policies mainly enhance competitiveness in low-end markets by facilitating firms' integration with local market resources. Additionally, regarding the temporal dimension of policy effectiveness, corporate adjustment responses are more immediate and rapid under high competition, while behavioral changes under low competition often result from cumulative effects of policy benefits. These differences across time periods and industry types indicate that policymakers should comprehensively consider market structure and competition intensity to design targeted policy instruments that fully unleash firms' market competitiveness potential and capacity for quality improvement.

The integration of theoretical and empirical research demonstrates that the mechanism by which the Belt and Road policy influences the quality of corporate exports is not a simple linear relationship, but rather a dynamic system formed through the interplay of multidimensional factors

such as market conditions, industry characteristics, technological capabilities, and temporal spans. Future studies could further focus on analyzing the heterogeneity between small and medium-sized enterprises and large enterprises; additionally, more precise optimization of the quantitative capture of policy intensity using panel econometric models would provide valuable analytical tools for exploring differences in policy transmission mechanisms across varying levels of competition (*Destination Country Policy Uncertainty*, 2019).

7 Conclusion and Policy Implications

7.1 Summary of Key Research Findings

This study employs a combination of theoretical analysis and empirical data to systematically examine the impact of the Belt and Road Initiative on the quality of China's manufacturing exports, and outlines from multiple perspectives the transmission pathways through which policy environments, corporate market choices, and strategic behaviors influence product quality. The main conclusions drawn are as follows: First, the implementation of the Belt and Road Initiative has significantly improved the overall quality level of China's manufacturing exports, achieved through trade facilitation, enhanced market access capabilities, and deepened international economic cooperation. The study reveals that among key participating countries in the Belt and Road Initiative, the unit export price (UPI) of China's manufacturing exports has risen markedly, particularly in equipment manufacturing and capital-and technology-intensive industries. Additionally, compared with non-Belt and Road participating countries, the unit added value of exports to Belt and Road countries increased by 12.6%, indicating that the policy environment plays a crucial guiding role in enhancing export product quality (*Belt and Road Initiative on China's Export Trade*, 2020).

Secondly, the study confirms that the degree of market diversification among enterprises serves as a crucial intermediary mechanism for the Belt and Road Initiative to drive quality improvement. Through path analysis of corporate export data, it was found that the Belt and Road Initiative has reduced market entry barriers in exporting countries and enhanced trade accessibility within geopolitical regions, thereby significantly expanding enterprises' international market coverage. Companies with a notably higher market diversification index exhibited approximately 1.8 times greater improvements in export product quality compared to those with unchanged or only marginal improvements. Mechanistic analysis indicates that the trend toward market diversification incentivizes enterprises to accelerate technological innovation investments and upgrade internal production processes, leading to the development of high-value-added products. This is particularly evident in the textile and home appliance industries, where diversified market demands have driven simultaneous advancements in product design and functional enhancements (*Trade Potential between China and Belt and Road Countries*, 2018).

Thirdly, the policy effects on enhancing corporate capabilities are significant. Under the Belt and Road Initiative, the policy support received by enterprises (such as logistics optimization and financing subsidies) has strengthened their willingness and capacity to invest in technological research and development, thereby improving the quality of export products. Micro-level enterprise analysis shows that for every 1 percentage point increase in R&D expenditure share, export product quality (per unit export price) improves by 3.4%. It is important to emphasize that this trend exhibits significant heterogeneity across different industries. For example,

capital-intensive sectors (mechanical equipment, automobile manufacturing) respond more sensitively to changes in the policy environment, with significantly better performance in product quality improvement compared to labor-intensive industries. These findings demonstrate that the Belt and Road Initiative serves as a key driver for quality transformation by reducing financing costs for participating enterprises and expanding their technical cooperation networks (Jiang et al., 2022).

Finally, the characteristics of China's trading partners play a significant moderating role in improving the quality of export products. The study finds that when the importing country has a high degree of economic freedom and marketization, the policy orientation of the Belt and Road Initiative can more directly promote improvements in the quality of corporate exports. In particular, the impact of infrastructure development and the signing of free trade agreements in the importing country is particularly pronounced, as it can offset some of the negative effects caused by trade inefficiencies. For example, a 1% increase in the infrastructure index corresponds to an approximately 0.8% rise in the unit value-added of China's exports (Wang and Yang, 2017). Additionally, for countries whose main exports consist of natural resources and primary commodities, the policy effect is weaker. This disparity indicates that the combination of the economic environment and industry structure significantly influences the effectiveness of the Belt and Road Initiative policies.

Overall, the Belt and Road Initiative has exerted a profound impact on improving the quality of China's manufacturing exports through multi-level policy transmission mechanisms. The policy effects are particularly evident in market diversification, capacity upgrading, and intensified competition in key industries, laying a solid foundation for deepening integration into global value chains and promoting high-quality development. However, the disparities in policy impacts across sectors and regions also indicate that future policy design needs to focus more on precision and differentiation to better support enterprises in leveraging the openness dividends brought by the Belt and Road Initiative, thereby providing stronger safeguards for the sustainable upgrading of China's manufacturing sector.

7.2 Implications for Corporate Strategy and Production Decision-Making

Against the backdrop of China's manufacturing transformation and upgrading, the Belt and Road Initiative has provided significant opportunities for corporate strategic adjustments and production decisions, while simultaneously imposing higher demands on quality competitiveness in international markets. From the perspective of corporate strategy formulation, the Belt and Road Initiative has unleashed multiple policy dividends, particularly manifested in how facilitated market access diversification and optimized resource allocation enhance corporate quality competitiveness. Enterprises need to establish adaptive strategic frameworks based on the open policies established by the initiative, achieving high-quality development through precise resource allocation and innovation-driven approaches.

First, the trade facilitation policies promoted by the Belt and Road Initiative, including tariff reductions and improved cross-border logistics efficiency, have opened new prospects for the international development of China's manufacturing sector, particularly high-value-added industries. Enhancing export product quality requires not only meeting the diverse demand standards of markets but also integrating quality orientation with economies of scale during production. It is recommended that manufacturing enterprises—especially those with scale advantages but insufficient motivation for quality improvement—strengthen their product differentiation competitiveness and strategically leverage opportunities presented

by diversified market entry. For instance, in recent years, demand for textile and light industrial products has steadily risen in Southeast Asian markets. Enterprises can utilize the cost-effective supply chain collaboration advantages across Belt and Road coverage regions, prioritizing quality as a core focus to gradually replace traditional "economies-of-scale" competition mechanisms. Throughout this process, internal control of product quality metrics—including dynamic monitoring of unit production costs and return rates—is particularly crucial, as changes in these indicators directly indicate whether quality improvements have achieved expected outcomes (Wang and Lu, 2019).

Secondly, the Belt and Road Initiative has profoundly redefined the geo-economic structure of target markets. The infrastructure investments under this initiative have significantly reduced market barriers in certain countries, providing support for enterprises' strategic marketing decisions. Under these conditions, companies need to segment the demand structure of target markets and dynamically optimize production organization methods by establishing a Heterogeneity in Market Demand Model. When formulating strategies, enterprises should shift from export-oriented models to value chain management approaches, setting long-term quality improvement goals and establishing strategic cooperation mechanisms to build a solid brand value foundation for their products in target markets and gradually establish a market position centered on quality competitiveness. Such strategies can be validated in practice through monitoring product quality fluctuations and user satisfaction surveys after market entry, thereby quantifying the impact effects of the Belt and Road policy (Jiang et al., 2022).

From a micro-level perspective of production decision-making, Belt and Road-related policies directly influence enterprises' R&D investments and production organizational structures. As infrastructure within the initiative scope gradually improves, the expansion of spatial layouts for manufacturing has become a widespread trend. The resulting incentives encompass not only quality optimization of individual production units but also overall efficiency enhancement of production networks. For instance, shipbuilding companies participating in Belt and Road port projects incorporate quality requirements for ocean-going shipping equipment into project investments, achieving dual value creation from process optimization to regional brand synergy. Recent econometric studies based on micro-data from Chinese enterprises demonstrate that policy-driven investments significantly enhance firms' internal technological development capabilities for product quality improvement through improved resource allocation and financing accessibility, manifested in higher R&D expenditure ratios and increased international patent applications. These technological investments improve process controllability and resource optimization efficiency, thereby shifting production orientation toward quality-driven models (*Destination Country Policy Uncertainty*, 2019).

Overall, the Belt and Road Initiative provides enterprises with a solid policy foundation and resource support for their strategic planning and production decisions, while also requiring them to strengthen internal quality management and technological capacity building alongside external support. Strategy formulation should be guided by policy directions and based on market diversification, aiming to tap into the multi-dimensional added value driven by quality orientation; production decisions must focus closely on two dimensions—technological innovation and efficiency improvement—to establish a synergistic system for high-quality product output. The long-term nature of these policies creates a stable practical environment for China's manufacturing sector to engage in global high-quality competition. Enterprises should fully leverage these policy benefits, prioritize quality-oriented upgrades as the core, achieve the strategic goal of moving from the lower to the higher end of the value

chain, and effectively address the complex challenges of quality competition in the context of globalization.

7.3 Policy Recommendations for the High-Quality Development of "Belt and Road"

The ongoing advancement of the Belt and Road Initiative has provided opportunities and momentum for China's manufacturing sector to compete on quality globally. However, the implementation of this macro policy still requires distinct regional adaptation strategies and targeted industry-specific support measures to enhance positive spillover effects on economies along the route and deepen the quality of industrial chain cooperation. At the policy recommendation level, practical development guidelines should be proposed from multiple dimensions—including market access, institutional safeguards, technological collaboration, and capital optimization—with focused recommendations tailored to potential pathways for high-quality cooperation under the Belt and Road framework.

First, the guiding role of policies in upgrading production organization methods should be strengthened to establish new drivers for improving export product quality based on industry characteristics and regional needs. Specifically, by optimizing existing policy tools such as trade subsidies, financing support, and tax incentive programs, targeted differentiated product quality competition strategies should be promoted among export enterprises for developing markets along the Belt and Road. Taking technology-intensive industries as an example, in sectors like automobiles and high-end machinery, the proportion of R&D funding investment should be increased, while international high-standard quality certification systems can be introduced through intergovernmental cooperation agreements. Leveraging the trade advantages of low tariff barriers existing in countries within the Belt and Road framework, a competitive quality brand positioning can be gradually established. Compared with capital- and labor-intensive industries such as textiles, apparel, and home appliances, a transition from "cost advantage" to quality-oriented approaches is necessary. On one hand, this involves supporting enterprises in establishing localized production bases and optimizing manufacturing processes; on the other hand, actively encouraging export products to incorporate region-specific design elements to better meet diverse market demands.

Secondly, it is essential to further enhance the targeted support level of infrastructure connectivity policies, strengthen interregional infrastructure integration, and provide adequate logistical safeguards for manufacturing export enterprises, thereby indirectly improving the supply stability and quality reliability of export products (*Export Trade Potential for Belt and Road Countries*, 2018). It is recommended to designate countries along the Belt and Road as key logistics nodes, prioritize investment in infrastructure projects, and optimize transit times and logistics efficiency in transportation processes. Leveraging modern information and communication technologies (ICT), a supply chain collaboration-driven industrial network can be gradually established to enhance real-time alignment between production resources and market dynamics across different countries. For instance, the railway network deployment by China enterprises in Central Asia can effectively reduce transportation costs while fostering inclusive cooperation among small and medium-sized enterprises in the supply chain, significantly enhancing product delivery quality.

Meanwhile, emphasis should be placed on a comprehensive policy framework that integrates technological collaboration and human resource development. By establishing R&D cooperation bases based on advanced manufacturing technologies, effective technology spillovers and reverse innovation feedback can be fostered between Belt and Road countries and Chinese enterprises. At the governmental level, targeted policies may be

introduced to encourage Chinese manufacturing exporters to participate in major cross-border technological projects along the Belt and Road, thereby assisting participating countries in upgrading their technological infrastructure and enhancing their capacity to integrate with China's "smart manufacturing" model. Domestically, efforts should focus on developing high-skilled workforce training programs through partnerships with universities or technology centers along the Belt and Road, leveraging technology transfer and capacity building to further establish a sustainable labor skills ecosystem (*Belt and Road Initiative on China's Export Trade*, 2020).

Furthermore, optimizing capital financing within the regional financial cooperation framework of the Belt and Road Initiative is a necessary condition for advancing quality-oriented development. It is recommended that the government establish a dedicated export financing fund to prioritize support for small and medium-sized manufacturing enterprises in technological investment and brand development along the route countries; and expand capital financing platforms by deepening collaboration with multinational financial institutions such as the Asian Infrastructure Investment Bank (AIIB), thereby enhancing the capacity to meet foreign exchange liquidity demands of economies along the Belt and Road and ensuring the stability of cross-border RMB settlement payments. During the establishment of long-term cooperative relationships, financial support should be leveraged to assist enterprises in setting up cross-border R&D centers, patent technology research facilities, or innovative R&D laboratories, thereby strengthening their competitive edge in key areas of quality excellence.

In summary, policy designs aimed at advancing the high-quality development goals of the Belt and Road Initiative should incorporate a long-term cooperation orientation that prioritizes quality across multiple dimensions such as market, technology, and finance. This approach not only incentivizes enterprises to comply with national policies but also effectively highlights the positive economic impacts of the Belt and Road Initiative on a global scale. By optimizing institutional frameworks and policy implementation mechanisms, the Belt and Road Initiative can achieve more comprehensive and profound high-quality development.

7.4 Research Limitations and Future Research Directions

Although this study provides important insights into the impact of the Belt and Road Initiative on the quality of China's manufacturing export products, it still has certain limitations that warrant further exploration in future research. First, regarding variable measurement, this study primarily employed the Unit Price Index (UPI) to assess product quality. While this method is widely used in international trade, it may be insufficient to fully capture quality changes in high-end differentiated products, especially when enterprises adopt flexible pricing strategies and products have complex characteristics. Additionally, due to constraints imposed by the technical complexity of export products and industry-specific features, the comparability of UPI across industries limits its effectiveness; future research should therefore introduce multi-dimensional quality measurement systems, such as indicators based on export enterprises' patent applications, innovation characteristics, or product life cycle features, to enhance the accuracy of quality assessment. Furthermore, the measurement of policy participation intensity relies mainly on the number of enterprises involved in Belt and Road projects and their logistics contribution, which fails to comprehensively reflect the differential impacts of various policy tools on corporate behavior. For instance, government-provided adjustments to export tax rebates and financing support policies may exert more direct incentives on technological investment behaviors; future research

could explore distinguishing the specific effects of different policy instruments and refining corresponding metrics accordingly.

Although the endogeneity issue of the regression model has been addressed using instrumental variable methods, potential omitted variable bias may still exist. For example, exogenous factors such as fluctuations in destination country policies and non-tariff trade barriers may play a significant role in influencing export quality (*Destination Country Policy Uncertainty*, 2019), which have not been separately controlled for in the model. Future research could enhance the model's identification capacity by incorporating macro-level indicators of destination country policy uncertainty (Economic Policy Uncertainty Index, EPU) or dynamic trade concession data. Additionally, this study employed a static panel dataset primarily based on Chinese customs data, which may overlook the long-term, dynamic impacts of Belt and Road policy implementation. Dynamic panel models or difference-in-differences (DID) approaches could better capture the sustained driving effects of policies on corporate export behavior.

The selection of the study sample still has certain limitations. Although this study focuses on five key manufacturing sectors, it does not encompass groups such as light industry and small and micro enterprises that are particularly sensitive to international market fluctuations. For instance, the textile and consumer electronics industries may rapidly adjust their export strategies in response to demand changes during the initial phase of policy implementation; however, this study lacks further comparative analysis regarding inter-industry effect heterogeneity. Additionally, firms across different regions may exhibit varying responses due to geographical advantages and policy incentives. Nevertheless, constrained by data availability, this study fails to fully examine how regional locations (e.g., southeastern coastal areas versus inland provinces) and trade partner characteristics (Southeast Asian countries versus Central Asian countries) influence differences in export product quality. Future research should expand the dataset to address this limitation (*Belt and Road Initiative on China's Export Trade*, 2020; *Export Trade Potential for Belt and Road Countries*, 2018).

Regarding the exploration of intermediary mechanisms, although this study has validated the indirect impact of the Belt and Road Initiative on quality improvement through market diversification and corporate capability enhancement, the specific pathways through which these mechanisms operate require further clarification. For instance, whether enterprises leverage R&D investment to expand intellectual property rights or improve product quality by establishing global supply chain networks under Belt and Road policy incentives remains hypothetical at present, lacking substantial empirical support. Future research could integrate micro-level corporate data to examine corporate response mechanisms from multidimensional perspectives such as capital reallocation, technology spillover effects, or organizational efficiency improvements. Additionally, this study fails to adequately analyze management's subjective responses to policy changes, particularly how differences in policy awareness and implementation capabilities may influence export performance. Therefore, incorporating survey or case study data alongside executive perception variables (e.g., policy sensitivity, market expectation adjustments) would provide new insights into mechanism analysis.

Finally, from a theoretical perspective, existing research largely relies on traditional international trade theories, and data-driven empirical validation remains relatively limited, making it difficult for conclusions to fully accommodate export upgrading practices under complex policy environments. Future studies could adopt an industrial economics approach combined with dynamic theoretical models of open macroeconomics to gradually establish a systematic theoretical framework for how the Belt

and Road Initiative promotes export quality improvement. This would not only explain the universal patterns faced by Chinese enterprises during their transformation but also effectively guide export optimization practices in other emerging economies.

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