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RESEARCH ARTICLE

# Deepening of Free Trade Agreement Participation and Firm-Level Export Product Quality*

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**Abstract**

Deepening of free trade agreement (FTA) participation is a core strategy for enhancing firm-level export quality and efficiency, addressing competitive pressures in international markets, and achieving high-quality economic development. Based on the measurement of the firm-level deepening of FTA participation indicator, this paper explores its impact on firm-level export product quality and the underlying mechanisms. Research results indicate that deepening of FTA participation promotes the upgrading of firm-level export product quality, a conclusion that remains robust after endogeneity tests and multiple robustness checks. Mechanism analysis results reveal that deepening of FTA participation impacts firm-level export product quality by improving intermediate goods input quality and reducing intermediate goods input cost. Heterogeneity analysis results indicate that deepening of FTA participation has a more significant positive impact on the export quality of firms with stronger institutional linkage intensity, greater dependence on international supply chains, and those not located in high-level opening-up zones. Structural decomposition and export dynamics analysis results demonstrate that deepening of FTA participation drives quality upgrading by facilitating the exit of low-quality products and the entry of high-quality products through the survival-of-the-fittest effect. In the context of a complex and volatile international environment, this paper provides theoretical foundations and policy implications for Chinese firms to cope with changes in the external environment and achieve high-quality development of export trade.

**Keywords** free trade agreement (FTA); deepening of participation; export product quality; intermediate goods; high-quality development

## 1 Introduction and Literature Review

The report to the 20th National Congress of the Communist Party of China states the need to promote high-standard opening up, upgrade trade in goods, and accelerate China's transformation into a trader of quality (Xi, 2022). This reflects the strategic requirement for China's export trade to shift from scale-driven growth to quality-oriented development. As a key manifestation of China's national innovation capability and competitiveness, export product quality is directly tied to the country's competitiveness in the international market and the global image of Chinese brands. It is fundamental to China's efforts in building itself

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into a trader of quality (Su et al., 2018). As the world's largest developing country, China has consistently committed to strengthening quality management and enhancing export competitiveness. It has successively formulated strategic plans such as "Made in China 2025" and high-quality development to support firms in increasing R&D investment and bolstering the development of core technologies and self-owned brands. Driven by relevant policies, China has achieved notable success in improving the quality of its export products. In 2022, mechanical and electrical products accounted for 57.8% of China's total exports, with rapid growth in exports of high-tech products such as new energy vehicles and photovoltaic equipment, reflecting an enhancement in the technological content and added value of export products. At the same time, the international certification capabilities of Chinese firms have also been significantly improved. More firms have obtained ISO 9001 quality management system certification, further solidifying the credibility and competitiveness of their products in the global market.

In recent years, free trade agreements (FTAs) have become an important institutional arrangement for promoting international trade. Their core function lies in reducing trade costs and fostering a relatively open trade environment by cutting tariffs, lowering non-tariff barriers, and strengthening investment cooperation (Han et al., 2018). Most extant literature has examined the economic effects of FTAs from perspectives such as whether FTAs are signed, the depth of individual FTA provisions, and FTA quality. These studies have found that the signing of FTAs impacts the signatory parties' technological levels (Bustos, 2011; Liu & Ma, 2020), export scale (Qian & Gong, 2017), outward investment (Yang & Tie, 2023), and value chain linkages (Lü et al., 2022). However, existing research primarily focuses on the economic effects of the signing of a trade agreement or the depth of its provisions from a macro-level perspective. There is relatively little in-depth investigation from a micro-level perspective into the degree of firms' participation in FTAs and whether firms can translate the policy dividends brought by FTAs into tangible competitive advantages. In theory, deepening of FTA participation can significantly impact firm-level export product quality through multiple mechanisms. Firstly, it reduces firms' intermediate goods input cost, which enhances the price competitiveness of their products in the international market. This lays the foundation for firms to expand market share and achieve the scale effect (Baier & Bergstrand, 2009). Secondly, it exerts a profound impact on firm-level export product quality through market incentive mechanisms. For instance, the tariff concessions under FTAs free up corporate capital, thereby increasing R&D investment, improving production technologies, and ultimately enhancing export product quality (Lin & Bao, 2018). As firms deepen participation in FTAs, a series of pressing questions emerges: Can firm-level deepening of FTA participation help improve export product quality? What are the underlying mechanisms at play? Does the positive impact on export product quality vary across different types of firms?

The literature relevant to this paper primarily falls into three categories. Firstly, quantitative research involving deepening of FTA participation. One strand employs survey methods to assess FTA utilization. Arudchelvan and Wignaraja (2016), as well as Yue and Han (2020),

utilize global and Chinese data respectively to estimate FTA utilization rates, finding that both the overall and detailed firm-level FTA utilization rates in China are generally low. Another strand uses formulaic methods with import trade value data to estimate the degree of deepening of FTA participation. Hayakawa et al. (2016) define the FTA utilization rate as the share of a firm's imports that use FTA preferential tariff rates in its total imports, and estimate the firm-level FTA utilization rate indicator based on product-specific import data. Han et al. (2018) establish a theoretical model incorporating the firm heterogeneity hypothesis to measure firms' FTA utilization costs, and further estimate the utilization rates of China's FTAs at both the country and industry levels. Lü et al. (2023), based on product-level data and using the FTA utilization rates published by the General Administration of Customs of the People's Republic of China (GACC), estimate China's FTA utilization rates across different years, providing theoretical support for the scientific assessment of China's FTA utilization rates. Secondly, research on factors influencing firm-level export product quality. Regarding internal influencing factors, firms' improvements in digital technology (Zhu et al., 2023) and levels of outward direct investment (Yu et al., 2021) can generate endogenous momentum for the upgrading of export product quality. Concerning external driving factors, trade liberalization measures such as tariff reductions (Amiti & Khandelwal, 2013), the intensity of government subsidies (Zhang et al., 2015), and policies promoting consumption upgrading (Jiang et al., 2024) can all serve as important means to drive the upgrading of export product quality. Thirdly, research involving trade liberalization and exports. Sheng and Mao (2017) examine the impact of import trade liberalization on the export technology sophistication of China's manufacturing sector from both firm and industry perspectives. They find that import trade liberalization enhances manufacturing export technology sophistication through the R&D innovation mechanism, while also improving firms' export technology sophistication via competition effects and variety effects. Wei and Zhang (2019), using China's accession to the World Trade Organization (WTO) as a quasi-natural experiment, demonstrate from meso and macro perspectives that lowering import tariffs can increase the domestic value-added rate of exports. Zheng and Peng (2023) investigate the impact of trade liberalization on export product quality from the perspective of FTAs. They find that the FTA signing and the increased FTA depth can promote the upgrading of export product quality. Based on the aforementioned research, this paper draws on the methodologies of Keck and Lendle (2012) and Han et al. (2018) to measure the firm-level deepening of FTA participation indicator. Using merged data from the Chinese Customs Database and the Chinese Industrial Enterprise Database, it explores the impact of deepening of FTA participation on the upgrading of firm-level export product quality and its underlying mechanisms.

Compared with extant literature, the potential marginal contributions of this paper are as follows. Firstly, in terms of research perspective, it interprets the factors influencing the upgrading of Chinese firms' export product quality from the angle of firm-level deepening of FTA participation, providing new insights for maintaining stability while improving quality in foreign trade. In extended analyses, it further examines the impact of deepening

of FTA participation on export product quality through quality structural decomposition and export duration perspectives, expanding the research dimensions of FTAs. Secondly, in terms of the analytical framework. Based on the firm-level export product quality determination model, this paper introduces deepening of FTA participation indicator through intermediate goods input quality and cost, constructs a theoretical analytical framework using a partial equilibrium model, and investigates the internal mechanisms through which deepening of FTA participation impacts firm-level export product quality. Thirdly, in terms of research methodology. Utilizing trade flow data disaggregated by product and export destination country matched with data from the Chinese Customs Database, the paper measures the firm-level FTA utilization rate indicator to represent deepening of FTA participation. It systematically describes the utilization rates of different FTAs and the dynamic evolution trends of firm-level FTA utilization rates, providing empirical support for relevant research.

## 2 Theoretical Framework

This paper fully considers the real-world characteristics of improved intermediate goods input quality and reduced intermediate goods input cost resulting from deepening of FTA participation, incorporates these mechanisms into the analytical framework of Khandelwal et al. (2013), and establishes a theoretical framework on how deepening of FTA participation impacts firm-level export product quality.

### 2.1 Consumer Behavior

Drawing on the demand framework of Khandelwal et al. (2013), this paper assumes that consumer utility in the export destination country depends on both the quantity and quality of the products consumed. Accordingly, the constant elasticity of substitution (CES) utility function of consumers can be expressed as:

$$U=\left[\int_{\theta\in\Omega}(\lambda_\theta q_\theta)^{\frac{\sigma-1}{\sigma}}\mathrm{d}\theta\right]^{\frac{\sigma}{\sigma-1}}, \tag{1}$$

where $U$ is the consumers' utility function, $\theta$ represents a product, $\Omega$ denotes the set of products purchased by consumers, $\lambda_\theta$ is the quality of product $\theta$, and $q_\theta$ is the consumption quantity of product $\theta$.

Furthermore, under the premise of utility maximization, consumers need to satisfy the following condition:

$$\text{s.t.}\int_{\theta\in\Omega}p_\theta q_\theta\mathrm{d}\theta=I, \tag{2}$$

where $I$ denotes consumers' total income, and $p$ is the price of the product. By combining equations (1) and (2) with the first-order condition for consumer utility maximization, the optimal consumption quantity for the product can be expressed as:

$$q_\theta = \lambda_\theta^{\sigma-1} P^{\sigma-1} \frac{I}{p_\theta^\sigma}, \tag{3}$$

where $P = \left[\int_{\theta\in\Omega} p_\theta^{1-\sigma} \lambda_\theta^{\sigma-1} \mathrm{d}\theta\right]^{\frac{1}{1-\sigma}}$.

## 2.2 Producer Behavior

This paper assumes that firms in a monopolistically competitive market use only labor and intermediate goods inputs in final goods production. It further assumes constant returns to scale between input and output. Drawing on the approach of Ma and Wang (2024), intermediate goods input $M$ is defined as depending on two factors. The first is the intermediate goods input quantity, $\tilde{\omega}_m$, which is determined by factors such as intermediate goods import prices. The second is the intermediate goods input quality, $\psi_m$, which is determined by factors outside the model, such as the supply conditions in the source country of the intermediate goods. Accordingly, the production function can be expressed as:

$$F(L, M) = F(L, \tilde{\omega}_m, \psi_m) = \varphi L^{1-\alpha} (\tilde{\omega}_m \psi_m)^\alpha, \tag{4}$$

where $1 - \alpha$ and $\alpha$ represent the output elasticity of labor and intermediate goods, respectively, $\varphi$ is productivity, and $L$ and $M$ denote labor and intermediate goods input, respectively.

To simplify the model, the wage level is normalized to 1. Since the optimal input quantities of labor and intermediate goods depend on factor prices, the marginal cost of a firm exporting product $\theta$ can be expressed as:

$$MC_\theta = \frac{\delta q_\theta^\gamma P_m^\alpha}{\varphi \psi_m^\alpha}, \tag{5}$$

where $\delta = \alpha^{-\alpha} (1 - \alpha)^{\alpha-1}$ is a constant; $\gamma$ is the quality elasticity of variable cost, and $\gamma < 1$; $P_m$ is the price of the intermediate goods input. Drawing on the approach suggested by Fan et al. (2022) and Ma and Wang (2024), the intermediate goods input quantity required for production by a firm is considered an aggregate of a bundle of intermediate goods, which can be expressed as:

$$\tilde{\omega}_m = \Lambda \exp\left[\int_0^{+\infty} a(h) \ln c(h) \mathrm{d}h\right], \tag{6}$$

where $\Lambda = \exp\left[\int_0^{+\infty} a(h) \ln a(h) \mathrm{d}h\right]$; $a(h)$ is the input share, satisfying $\int_0^{+\infty} a(h) \mathrm{d}h = 1$; $c(h)$ is the quality-adjusted quantity of input $h$. Accordingly, the price of the intermediate goods input can be obtained as:

$$P_m = \exp\left[\int_0^{+\infty} a(h) \ln p(h) \mathrm{d}h\right], \tag{7}$$

where $p(h)$ is the quality-adjusted input cost for the firm. Assume that the firm sources intermediate goods from two channels: importing from abroad and procuring domestically. The input cost for importing intermediate goods from abroad is represented as $\tau p^f(h)$, where $p^f(h)$ denotes the domestic price in the source country, and $\tau$ reflects the import cost (including tariffs and customs clearance review expenses). The price of procuring intermediate goods

domestically can then be expressed as $p^d(h)$. In this case, the firm's choice of intermediate goods is to satisfy $p(h) = \min\{\tau p^f(h), p^d(h)\}$, meaning the firm would choose the channel with the lower input cost to procure intermediate goods. Further assume a threshold $h^*$ where domestic and foreign prices are equal. The firm would import intermediate goods from abroad when $h < h^*$, and conversely, would procure domestically. Therefore, the input price of intermediate goods can be expressed as:

$$P_m = \exp\left[\int_0^{h^*} a(h)\ln(\tau p^f(h))\mathrm{d}h + \int_{h^*}^{+\infty} a(h)\ln(p^d(h))\mathrm{d}h\right]. \tag{8}$$

Similarly, given that intermediate goods input quality is exogenously determined, and following the approach of Ma and Wang (2024), the standardized quality of intermediate goods imported from abroad is set as $\phi(h)$, while the standardized quality of those procured domestically is set as $\rho(h)$. Correspondingly, there exists a threshold $h^*$ for switching from importing from abroad to procuring domestically. The firm imports intermediate goods from abroad when below this threshold and procures intermediate goods domestically when above it. Therefore, the intermediate goods input quality is similarly expressed as:

$$\psi_m = \exp\left[\int_0^{h^*} a(h)\ln(\phi(h))\mathrm{d}h + \int_{h^*}^{+\infty} a(h)\ln(\rho(h))\mathrm{d}h\right]. \tag{9}$$

Deepening of FTA participation at the import level impacts firms' production and operational activities via intermediate goods input quality and intermediate goods input cost. First, firm-level deepening of FTA participation directly reduces firms' tariff costs and various trade barriers for importing intermediate goods, making it easier for Chinese firms to access high-quality foreign inputs, thereby directly improving intermediate goods input quality (Wei & Zhang, 2019). At the same time, deepening of FTA participation broadens firms' import channels, enabling them to procure a wider variety of intermediate goods inputs, including components and raw materials of varying specifications and technological origins. This enhances the flexibility of firms' production factor combinations and effectively raises the overall quality of their intermediate goods inputs (Sheng & Mao, 2017). Therefore, the relationship between intermediate goods import quality and firm-level deepening of FTA participation can be specified as:

$$\phi(h) = \phi_0 e(fta), \tag{10}$$

where $\phi_0$ represents a firm's initial intermediate goods import quality, $e(fta)$ is a function of firm-level deepening of FTA participation, and $e'(\cdot) > 0$ indicates that intermediate goods input quality improves with firm-level deepening of FTA participation.

Second, deepening of FTA participation enables firms to directly reduce the cost of importing intermediate raw materials and equipment under the premise of tariff reductions and the design of regional cumulation rules of origin (Han et al., 2018). Meanwhile, trade liberalization measures and improvements in the investment environment within trade agreements also significantly reduce firms' transaction and information costs (Zhen & Liu, 2023). Overall, these cost-saving measures can reduce the cost of importing intermediate goods for firms. Therefore, the relationship between intermediate goods import cost and firm-

level deepening of FTA participation can be specified as:

$$\tau = \tau_0 g(fta), \tag{11}$$

where $\tau_0$ represents the initial import cost of intermediate goods, $g(fta)$ is a function of firm-level deepening of FTA participation, and $g'(\cdot)<0$ indicates that firm-level deepening of FTA participation reduces the import cost, i.e., $\partial\tau/\partial fta<0$.

In addition to the above marginal costs, firms also require certain fixed cost inputs, which can be expressed as:

$$FC_\theta = f_0 + f\lambda_\theta^\beta, \tag{12}$$

where $f_0$ represents the fixed cost of the firm, and $f_0>0$; $\beta$ is the elasticity of fixed cost with respect to quality for product $\theta$, and $\beta>0$.

Under a monopolistically competitive market structure, firms set prices through a markup over cost, with the price expressed as:

$$p_\theta = \frac{\sigma}{\sigma-1} MC_\theta. \tag{13}$$

The firm's profit function can be further derived as:

$$\pi_\theta = p_\theta q_\theta - MC_\theta q_\theta - FC_\theta. \tag{14}$$

Substituting equation (3), equation (5), and equation (12) into equation (14) simplifies the profit function to:

$$\pi_\theta = \frac{\sigma^{-\sigma}}{(\sigma-1)^{1-\sigma}}\left(\frac{\varphi\psi_m^\alpha P}{\delta P_m^\alpha}\right)^{\sigma-1}\lambda_\theta^{(\sigma-1)(1-\alpha)} I - f_0 - f\lambda_\theta^\beta. \tag{15}$$

### 2.3 Determination of Firm-Level Export Product Quality

Taking the derivative of equation (15) with respect to product quality yields:

$$\frac{(\sigma-1)^\sigma}{\sigma^\sigma}(1-\alpha)\left(\frac{\varphi\psi_m^\alpha P}{\delta P_m^\alpha}\right)^{\sigma-1}\lambda_\theta^{(\sigma-1)(1-\alpha)-1} I - \beta f\lambda_\theta^{\beta-1} = 0. \tag{16}$$

The expression for firm-level export product quality under equilibrium conditions is:

$$\lambda_\theta = A^{1/\gamma}\delta^{(1-\sigma)/\gamma}P_m^{\alpha(1-\sigma)/\gamma}\psi_m^{\alpha(\sigma-1)/\gamma}\varphi^{(\sigma-1)/\gamma}, \tag{17}$$

where $A \equiv \frac{(\sigma-1)^\sigma(1-\alpha)}{\beta f\sigma^\sigma}\frac{I}{P^{1-\sigma}} > 0$, $\gamma = \beta - (\sigma-1)(1-\alpha) > 0$.

As can be seen from equation (17), firm-level export product quality is related to a series of factors. This paper focuses on the factors influenced by firm-level deepening of FTA participation, namely the two variables of intermediate goods input quality and intermediate goods input cost. Further taking the partial derivative of firm-level export product quality with respect to firm-level deepening of FTA participation yields:

$$\frac{\partial\lambda_\theta}{\partial fta} = W\left[P_m^{\alpha(1-\sigma)/\gamma}\psi_m^{(\alpha(\sigma-1)/\gamma)-1}\frac{\partial\psi_m}{\partial\phi_m}\frac{\partial\phi_m}{\partial fta}\psi_m^{\alpha(\sigma-1)/\gamma} - P_m^{(\alpha(1-\sigma)/\gamma)-1}\frac{\partial P_m}{\partial\tau}\frac{\partial\tau}{\partial fta}\right], \tag{18}$$

where $W = A^{1/\gamma}\delta^{(1-\sigma)/\gamma}\varphi^{(\sigma-1)/\gamma}\alpha(\sigma-1)/\gamma > 0$, $\partial\psi_m/\partial\phi_m > 0$, $\partial\phi_m/\partial fta > 0$, $\partial P_m/\partial\tau > 0$, and $\partial\tau/\partial fta < 0$, that is $\partial\lambda_\theta/\partial fta > 0$. Based on this, the following research hypotheses are proposed:

*H1*: Deepening of FTA participation is conducive to improving firm-level export product

quality.

*H2*: Deepening of FTA participation promotes the upgrading of firm-level export product quality by improving intermediate goods input quality and reducing intermediate goods input cost.

## 3 Indicator Measurement and Stylized Facts

### 3.1 Indicator Specification for Deepening of FTA Participation

#### *3.1.1 Indicator Measurement for Deepening of FTA Participation*

This paper uses the FTA utilization rate to represent deepening of FTA participation indicator. Drawing on the research framework of Keck and Lendle (2012) and integrating methods from the GACC and the WTO, the FTA utilization rate is defined as the ratio, under a specific FTA scheme, of the import value actually using preferential tariff rates to the total import value eligible for preferential access under the scheme. To calculate the import value that actually uses FTA preferential tariffs, this paper further introduces the FTA utilization threshold variable to represent the actual cost of using an FTA. This cost includes various explicit and implicit costs associated with FTA utilization (Lü et al., 2023), such as the information cost for learning FTA policies, production adjustment cost, and certificate application cost to meet FTA rules of origin requirements. Keck and Lendle (2012) note that this cost is relatively fixed. This paper assumes that the FTA utilization threshold takes the form of a fixed cost in each year, and that the FTA preferential tariff rate is applied only when the difference between the Most-Favored-Nation (MFN) tariff rate and the FTA preferential tariff rate exceeds this threshold. The formula for calculating the FTA utilization rate can be expressed as:

$$fta_{jt} = \frac{import^{r}_{jt}}{import^{q}_{jt}},\ t^{MFN}_{jt} - t^{FTA}_{jt} \geqslant \lambda_j. \tag{19}$$

where $fta_{jt}$ represents the FTA utilization rate indicator for country $j$ in year $t$; $t^{MFN}_{jt} - t^{FTA}_{jt}$ is the difference between the MFN tariff rate and the FTA preferential tariff rate in year $t$; $\lambda_j$ is country $j$'s FTA utilization threshold; $import^{r}_{jt}$ denotes the import value that actually uses the FTA tariff rate when the difference $t^{MFN}_{jt} - t^{FTA}_{jt}$ between country $j$'s MFN tariff rate and FTA preferential tariff rate is greater than the threshold $\lambda_j$ in year $t$; and $import^{q}_{jt}$ is the total import value of products eligible for the FTA preferential tariff rate in year $t$ (the total import value is greater than 0 and the MFN tariff rate is greater than 0).

The specific measurement process includes the following steps:

Step 1: Estimating the FTA utilization threshold. This paper draws on the methodologies of Han et al. (2018) and Lü et al. (2023). Utilizing the import data disaggregated by product and export destination country from 2005 to 2018, the tariff rates disaggregated by export destination country and product, and the utilization rates for FTAs signed by China in 2013 as published by the GACC,[1] the utilization threshold values for each FTA are estimated. Firstly,

[1] The authors extend their gratitude to Associate Professor Lü Jianxing from the School of Economics and Statistics at Guangzhou University for his assistance with this indicator. The usual caveat applies.

based on the difference between the MFN tariff rate and the preferential tariff rate stipulated under the FTA provisions,[2] equation (19) is applied to calculate the utilization rate indicator for each FTA signed by China in 2013 under different threshold values. Secondly, if the calculated utilization rate exceeds the official figure published by the GACC, the threshold value is set higher; if it falls below the official figure, the threshold value is set lower. The process iterates until the threshold value that yields a utilization rate closest to the officially published figure is identified. This threshold is then adopted as the utilization threshold for that FTA across different years.

Step 2: Estimating FTA utilization rates for different years. Building on the estimated utilization threshold values for different FTAs from the step above, equation (19) is further applied to calculate the utilization rate indicator for the various FTAs signed by China in each year.

Step 3: Estimating firm-level FTA utilization rates. Building on the country-level FTA utilization rate indicator obtained above and following the approach of Qu and Yang (2024), the firm-level FTA utilization rate indicator is estimated. The estimation formula is:

$$fta_{it} = \sum_{j=1}^{J} \left( \frac{import_{ijt}}{\sum_{j=1}^{J} import_{ijt}} \times fta_{jt} \right), \tag{20}$$

where $fta_{it}$ is the firm-level FTA utilization rate indicator obtained after weighting by import value; $J$ denotes the number of import source countries for domestic firm $i$; and $import_{ijt}$ represents the import trade value of firm $i$ from country $j$.

### *3.1.2 Stylized Facts of Deepening of FTA Participation*

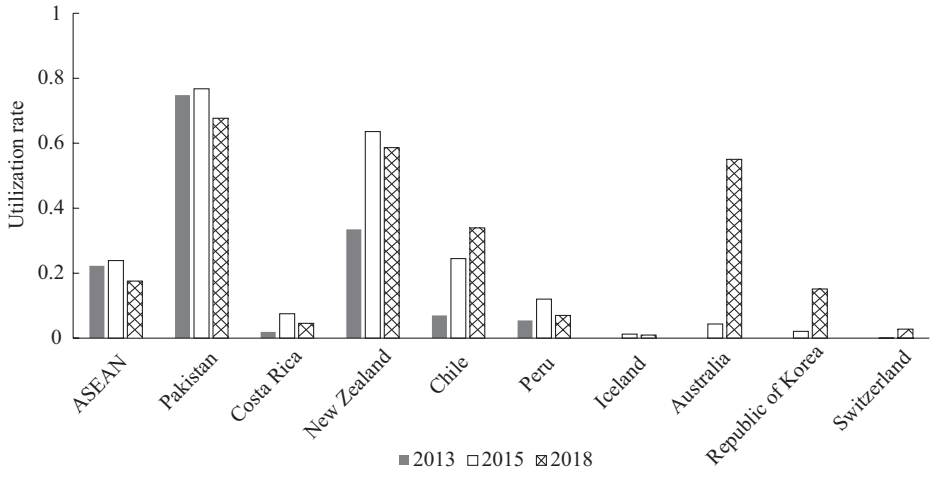
Figure 1 illustrates the utilization rates of various FTAs signed by China for the years 2013, 2015, and 2018.[3] The overall trend shows that the average utilization rate of FTAs signed by China increased from 18.16% in 2013 to 22.52% in 2018, indicating a general upward trend in China's FTA utilization. Notably, the utilization rates for FTAs with Pakistan and New Zealand are the highest, while those with Switzerland and Iceland are the lowest. This reflects significant variation in utilization rates across different FTAs, which may be related to the costs associated with using specific FTAs and the length of time since the FTAs were signed.

[2] The MFN tariff rates and the preferential tariff rates stipulated in the FTA provisions are obtained from the tariff concession schedules within the texts of various FTAs on the China FTA Service Network. For countries whose tariff concession schedules do not provide MFN tariff rates, the data are sourced from the World Bank's World Integrated Trade Solution (WITS) database. This constitutes a dataset at the China, export destination country, and product level.

[3] Due to space considerations, Figure 1 consolidates ten countries—Indonesia, Malaysia, the Philippines, Singapore, Thailand, Brunei, Vietnam, Laos, Myanmar, and Cambodia—under ASEAN for presentation. All other analyses in the text treat countries as independent units.

**Figure 1**

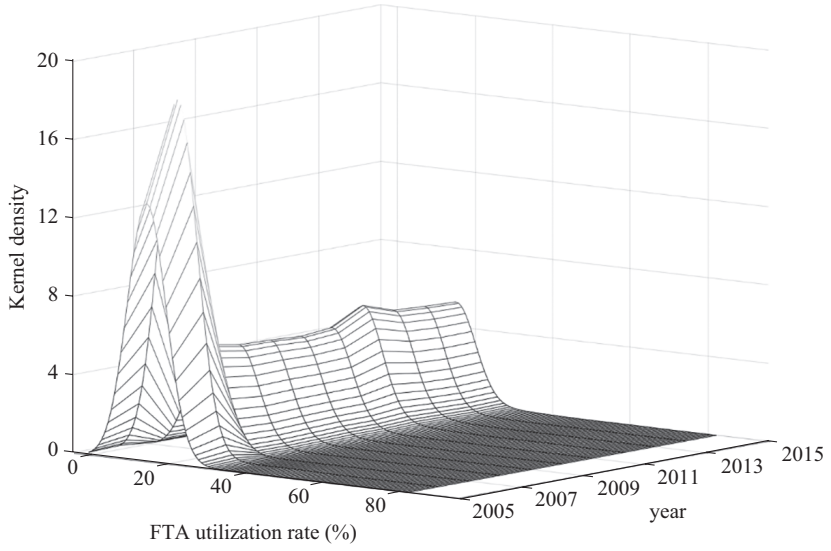
*Utilization Rates of Different FTAs Signed by China*




To further examine the dynamic distribution of firm-level deepening of FTA participation, this paper employs MATLAB 2023a software to perform Gaussian kernel density estimation on firm-level FTA utilization rates. As illustrated in Figure 2, the distribution of FTA utilization rates exhibits certain variation across different years. In the early stage of the sample period (for example, 2005), FTA utilization rates were predominantly concentrated in the lower range with high density. Over time, the peak of the kernel density gradually declines, and the distribution progressively shifts to the right (toward higher FTA utilization rates). This indicates that from 2005 to 2015, the FTA utilization rate of Chinese firms increased steadily, characterized by a transition from low-density concentration to higher-density clustering. The overall distribution of utilization rates gradually shifts to the right, with a particularly marked increase in the proportion of firms in the medium-to-high utilization range. This suggests that as policy dividends are progressively realized, firms' adaptability to and efficiency in utilizing FTA policies have strengthened over time, reflecting the steady improvement in the international competitiveness of Chinese firms. Meanwhile, the distribution of utilization rates does not diffuse uniformly. Instead, two relatively high-density regions are formed at both the low utilization range and the high utilization range, indicating a persistent polarization in firms' utilization of FTA policies. While some firms are able to fully capitalize on the preferential benefits offered by FTAs, others remain at lower utilization levels. This points to an imbalance in policy coverage and utilization effectiveness, which may be attributable to multiple factors such as firm-specific characteristics, industry attributes, or regional disparities.

**Figure 2**

*Three-Dimensional Kernel Density Estimation Results of Firm-Level Deepening of FTA Participation in 2005–2015*




### 3.2 Specification of Firm-Level Export Product Quality

This paper draws on the methodology of Khandelwal et al. (2013) by incorporating product heterogeneity into the analytical framework and employing the demand inversion approach to estimate the export product quality of Chinese firms. First, the product demand function in the destination country can be expressed as:

$$q_{ij\theta t} = p_{ij\theta t}^{-\sigma} \lambda_{ij\theta t}^{\sigma-1} \frac{I_{jt}}{P_{jt}}, \tag{21}$$

where $q_{ij\theta t}$ and $p_{ij\theta t}$ denote the quantity and price of product $\theta$ exported by firm $i$ to country $j$ in year $t$, respectively, while $P_{jt}$ and $I_{jt}$ represent the aggregate price index and total consumer expenditure in the destination market.

Second, taking the logarithm of both sides of equation (21) yields:

$$\ln q_{ij\theta t} = \phi_{jt} + \phi_{\theta} - \sigma \ln p_{ij\theta t} + \varepsilon_{ij\theta t}. \tag{22}$$

This paper introduces export destination country–year fixed effect $\phi_{jt}$ and product-level fixed effect $\phi_{\theta}$, and sets the random disturbance term as $\varepsilon_{ij\theta t} = (\sigma - 1) \ln \lambda_{ij\theta t}$, which contains information related to export product quality $\lambda_{ij\theta t}$. It is worth noting that directly estimating equation (22) using ordinary least squares (OLS) may yield biased parameter estimates due to simultaneity bias between price levels and product quality. To effectively address this endogeneity problem, this paper employs the average price of similar products exported by firm $i$ to third-country markets (excluding destination market $j$) in year $t$ as the core instrumental variable, and conducts a two-stage least squares (2SLS) estimation of equation

(22). The export product quality can then be expressed as:

$$\ln \hat{\lambda}_{ij\theta t} = \frac{\hat{\varepsilon}_{ij\theta t}}{\sigma - 1}. \tag{23}$$

Third, to facilitate comparisons of product quality across different time periods and countries, $\ln\hat{\lambda}_{ij\theta t}$ is further standardized to obtain the explained variable *quality* in this paper, expressed as:

$$quality_{ij\theta t} = \frac{\ln\hat{\lambda}_{ij\theta t} - \min \ln \hat{\lambda}_{ij\theta t}}{\max \ln\hat{\lambda}_{ij\theta t} - \min \ln \hat{\lambda}_{ij\theta t}}. \tag{24}$$

## 4 Model Design and Empirical Estimation

### 4.1 Model Specification

To systematically evaluate the impact of deepening of FTA participation on firm-level export product quality, this paper constructs a multi-dimensional fixed effects econometric model for empirical testing. The baseline regression equation is specified as follows:

$$quality_{ij\theta t} = \alpha + \beta_1 fta_{it} + \beta_2 X + \delta_i + \delta_t + \delta_j + \delta_\theta + \varepsilon_{ij\theta t}, \tag{25}$$

where $i$, $j$, $\theta$, and $t$ denote the exporting firm, export destination country, export product category, and year, respectively; $quality_{ij\theta t}$ represents export product quality; $fta_{it}$ is deepening of FTA participation indicator for firm $i$ in year $t$, measured by the FTA utilization rate as constructed above; $X$ is a series of control variables; $\delta_i$, $\delta_t$, $\delta_j$, and $\delta_\theta$ represent export firm, year, export destination country, and product fixed effects, respectively; and $\varepsilon_{ij\theta t}$ is the random disturbance term.

Drawing on the approach of Qu and Yang (2024), this paper selects the following control variables: firm size (*size*), measured by the natural logarithm of total employment; firm age (*age*), processed by taking the logarithm of a firm's operating years, expressed as the natural logarithm of (current year minus firm registration year plus 1); asset-liability ratio (*asslia*), expressed as total liabilities divided by total assets; financing constraints (*fincon*), expressed as interest expense divided by fixed assets; return on assets (*asspro*), expressed as net profit divided by total assets; domestic sales share (*dome*), expressed as the proportion of industrial sales revenue to total operating revenue; labor productivity (*labor*), expressed as total industrial output value divided by number of employees; degree of industry monopoly, measured by the Herfindahl-Hirschman Index (*HHI*); economic level of each country (*gdp*), expressed as per capita GDP of the export destination country; exchange rate level of each country (*er*), measured by the real exchange rate.

The sample period used in this paper spans from 2005 to 2015, and the data are primarily derived from five sources: (1) the World Bank's WITS database which provides annual trade flow and tariff data at the export destination country–product level; (2) the FTA texts from the China FTA Service Network, involving FTA preferential tariff rates

and MFN tariff rates at the China–export destination country–product level; (3) the Chinese Customs Database which provides import and export data at the firm–product–export destination country–year level (Following the methodology of Shi et al. (2023), this paper processes the database by eliminating observations with missing key variables, single transaction values below USD 50, or product quantity units less than 1, and retains data with the largest number of counting units under the same product code); (4) the Chinese Industrial Enterprise Database which is used for measuring control variables (This paper processes the database by excluding sample observations with the number of employees fewer than nine and uniformly converts the industrial classification codes to the 2002 national economic industry classification codes); (5) the CEPII database which provides inter-country distance data and per capita GDP data for trading partner countries.

### 4.2 Baseline Regression

Table 1 presents the estimation results of equation (25). Column (1) reports the estimates from a specification that includes only the core explanatory variable, while controlling for firm, time, export destination country, and product variety fixed effects. The regression coefficient of the firm-level deepening of FTA participation indicator is significantly positive, indicating that deepening of FTA participation can promote the upgrading of firm-level export product quality. To mitigate concerns regarding omitted variable bias affecting the baseline results, Columns (2) and (3) progressively introduce control variables at the firm, industry, and country levels. The regression coefficients of the core variable remain significantly positive. Furthermore, considering that firms exporting the same product category may exhibit correlations leading to serial correlation issues, Column (4) further employs product-level clustered robust standard errors for regression. To sum up, after accounting for various potential influencing factors and autocorrelation concerns, this paper confirms that a positive correlation still exists between export product quality and firm-level FTA utilization rates. Consistent with the preceding theoretical analysis, firm-level deepening of FTA participation can not only reduce intermediate goods input cost and enhance firm profits, but also promote firms to optimize intermediate goods import strategies, expand the scope of trading partner countries, and facilitate technology spillover effects through imports of high-quality intermediate goods. This, in turn, fosters the diversification of firms' supply chains and productivity improvements, ultimately enabling the upgrading of export product quality. Accordingly, *H1* is validated.

**Table 1**
*Baseline Regression Results*

| Variable | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| *fta* | 0.0696*** | 0.0648*** | 0.0640*** | 0.0640** |
| | (0.019) | (0.019) | (0.019) | (0.027) |
| *size* | | 0.0060*** | 0.0060*** | 0.0060*** |
| | | (0.000) | (0.000) | (0.001) |
| *age* | | –0.0013* | –0.0013* | –0.0013 |
| | | (0.001) | (0.001) | (0.001) |
| *asslia* | | –0.0019** | –0.0018** | –0.0018* |
| | | (0.001) | (0.001) | (0.001) |
| *fincon* | | –0.0104 | –0.0099 | –0.0099 |
| | | (0.007) | (0.007) | (0.007) |
| *dome* | | –0.0165*** | –0.0167*** | –0.0167*** |
| | | (0.003) | (0.003) | (0.005) |
| *asspro* | | 0.0099*** | 0.0098*** | 0.0098*** |
| | | (0.002) | (0.002) | (0.002) |
| *labor* | | 0.0075*** | 0.0075*** | 0.0075*** |
| | | (0.000) | (0.000) | (0.000) |
| *HHI* | | | –0.0022 | –0.0022 |
| | | | (0.002) | (0.004) |
| *gdp* | | | 0.0114*** | 0.0114*** |
| | | | (0.002) | (0.003) |
| *er* | | | –0.0004 | –0.0004 |
| | | | (0.000) | (0.000) |
| Constant term | 0.5034*** | 0.4369*** | 0.3239*** | 0.3239*** |
| | (0.000) | (0.004) | (0.020) | (0.035) |
| Firm/year/destination country/product fixed effect | Control | Control | Control | Control |
| Clustering level | | | | Product |
| *n* | 5,568,909 | 5,568,909 | 5,568,909 | 5,568,909 |
| $R^2$ | 0.2592 | 0.2594 | 0.2594 | 0.2594 |

*Note.* Robust clustered standard errors are reported in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

## 4.3 Endogeneity Tests

### *4.3.1 Instrumental Variable Test*

Considering the potential presence of unobservable omitted variables and reverse causality in the preceding analysis, this paper draws on the methodologies of Yang et al. (2023) and Qu and Yang (2024) to construct a Bartik instrumental variable using the shift-share method and conducts 2SLS estimation. This method constructs an instrumental variable that satisfies both relevance and exogeneity based on the initial share and the aggregate growth rate of the analyzed variable. The constructed instrumental variable is correlated with the core explanatory variable while being uncorrelated with other residual terms. The variable is specified as follows:

$$fta_iv_{it} = \sum_{j,j\in N}\left\{\frac{import_{ijt=0}}{\sum_{j,j\in N} import_{ijt=0}} \times (1 + rate_{t=0,t}) \times fta^{j}_{t=0}\right\}, \tag{26}$$

where $import_{ijt=0}$ denotes the import value of firm $i$ from country $j$ in the base period; $rate_{t=0,t}$ represents the growth rate of the utilization rate of the FTA signed with country $j$ relative to the base period; and $fta^{j}_{t=0}$ is the FTA utilization rate indicator with country $j$ in the base period. The growth rate of FTA utilization at the country level $rate_{t=0,t}$ provides the only time-series variation, as all other relevant variables are time-invariant. Employing a two-way fixed effects model to absorb firm heterogeneity and macroeconomic shocks can ensure that the instrumental variable $fta_iv_{it}$ meets the strict exogeneity assumption. Additionally, as $fta_iv_{it}$ essentially estimates $fta_{jt}$, the relevance requirement is also satisfied. Table 2 presents the estimation results of the 2SLS regression. The regression coefficient of deepening of FTA participation remains significantly positive, indicating that after employing the instrumental variable to mitigate some endogeneity concerns, deepening of FTA participation still enhances firm-level export product quality, confirming the robustness of the preceding conclusions. Furthermore, in the under-identification test, the Kleibergen-Paap rk *LM* statistic rejects the null hypothesis at the 1% significance level, indicating the absence of an under-identification problem. In the weak instrumental variable test, the Kleibergen-Paap rk Wald *F* statistic exceeds the Stock-Yogo bias critical value of 16.38 at the 10% significance level, suggesting a strong correlation between the instrumental variable and the endogenous variable. Therefore, the instrumental variable selected in this paper is appropriate.

### *4.3.2 Sample Selection Bias Test*

As firms' entry into export markets is not entirely random, and the matching process between the Chinese Industrial Enterprise Database and the Chinese Customs Database inevitably results in certain sample losses, the baseline results may be subject to sample selection bias. This paper further employs the Heckman two-step method to check the robustness of the baseline regression results. The two-stage regression results of the Heckman model in Table 2

show that after including the inverse Mills ratio (*imr*) to correct for potential sample selection bias, the regression coefficient of deepening of FTA participation remains significantly positive, indicating the robustness of the preceding conclusions. Furthermore, the regression coefficient of the inverse Mills ratio is significantly negative, confirming the presence of self-selection issues and validating the appropriateness of the Heckman model estimation.

**Table 2**
*Regression Results of Endogeneity Analysis*

| Variable | 2SLS | | Heckman | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| *fta_iv* | 0.0217*** | | | |
| | (0.001) | | | |
| *fta* | | 0.2558* | –3.5088*** | 0.0639** |
| | | (0.143) | (0.199) | (0.028) |
| *imr* | | | | –0.0089** |
| | | | | (0.004) |
| Kleibergen–Paap rk *LM* | | 284.098 | | |
| | | [0.000] | | |
| Kleibergen–Paap Wald *F* | | 635.036 | | |
| | | {16.38} | | |
| Control variables | Control | Control | Control | Control |
| Firm–fixed effects | Control | Control | Control | Control |
| Year–fixed effects | Control | Control | Control | Control |
| Product–fixed effects | Control | Control | | Control |
| Export destination country fixed effects | | | | Control |
| Clustering level | Product | Product | | Product |
| *n* | 5,573,163 | 5,573,163 | 5,573,163 | 4,973,157 |
| $R^2$ | | 0.0043 | | 0.2588 |

*Note.* *p*-values are reported in brackets [ ]. The value in braces { } denotes the Stock-Yogo weak identification test critical value at the 10% significance level. Robust clustered standard errors are reported in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

### 4.4 Robustness Checks

Firstly, we replace the explanatory variable. This paper replaces deepening of FTA participation indicator with the overall FTA depth index to re-examine the baseline results. The data are

primarily sourced from the World Bank's Deep Trade Agreements Database. Specifically, following the methodology of Mattoo et al. (2020), the measurement of FTA depth takes into account the full coverage of 18 types of provisions. Next, the provisions are assigned values using the provision count index method proposed by Hofmann et al. (2017). Finally, the FTA depth is measured through vertical aggregation. Second, we replace the explained variable. The upgrading of export product quality encompasses multiple dimensions. In the context of China's foreign trade facing the dilemma of low-end lock-in, enhancing export product quality urgently requires strengthening firms' innovation capacity and cultivating new competitive advantages. Therefore, export technological sophistication can serve as a proxy variable for the upgrading of export product quality. This paper substitutes export product quality with export technological sophistication and re-estimates the baseline model. Third, we adjust the sample period. The 2008 global financial crisis significantly impacted international trade, and governments subsequently introduced various policies to promote their export trade. To avoid the influence of this financial shock on domestic export trade, this paper excludes all samples after 2008 and retains data from 2005–2007 to reestimate equation (25). It also excludes only the 2008 and 2009 sample data to re-examine the baseline model. Additionally, the selection criteria for enterprises above the designated size in the Chinese Industrial Enterprise Database changed after 2010, with the threshold for main business revenue raised from 5 million yuan to 20 million yuan. This change may lead to inconsistencies in the sample composition before and after the threshold adjustment, potentially biasing the preceding estimation results. This paper retains only sample firms with main business revenue exceeding 20 million yuan and re-runs the regression. Moreover, considering the issue of severe data missingness in certain years of the Chinese Industrial Enterprise Database, this paper excludes the samples for 2010 and 2015, for which data are substantially incomplete, and re-examines the baseline model. Fourth, adjust the sample data. The previous analysis employs unbalanced panel data, which fails to account for the dynamic behavior of firms entering and exiting export markets. In reality, the improvement in firm-level export product quality may stem from firms adjusting their own business scope, or it may result from the entry of high-quality firms or the exit of low-quality firms. To further rule out potential interference from firm survival dynamics on the core conclusions, this paper retains only firms that continuously operated throughout the sample period and re-estimates the baseline model. Meanwhile, the baseline regression examines the impact of firm-level deepening of FTA participation on export product quality using export product quality at the firm–export destination country–product–year level. Here, this paper directly measures export product quality at the firm level and investigates the impact of deepening of FTA participation on firm-level export product quality. All of the above robustness check results are consistent with the baseline regression results.[4]

[4] Due to space limitations, the results of the robustness checks are not reported here but are available upon request.

## 5 Mechanism Identification and Heterogeneity Analysis

### 5.1 Mechanism Identification

According to the theoretical model developed above, the impact of deepening of FTA participation on firm-level export product quality operates through two channels: intermediate goods input quality and intermediate goods input cost. Drawing on the approach of Jiang (2022), this paper constructs the following model to test the mechanisms through which deepening of FTA participation impacts firm-level export product quality, where *mechanism* denotes the mechanism variable:

$$mechanism_{ij\theta t} = \alpha + \beta_1 fta_{it} + \beta_2 X + \delta_i + \delta_t + \delta_j + \delta_\theta + \varepsilon_{ij\theta t}. \quad (27)$$

Regarding the measurement of intermediate goods input quality, this paper adopts a dual approach. Firstly, it measures the import quality of intermediate goods at the firm–product–destination country level and at the firm level, respectively, to proxy for intermediate goods input quality. Secondly, it further employs the variety of intermediate goods input as a proxy variable for intermediate goods input quality in the mechanism test. The variety of intermediate goods reflects the extent of firms' diversified choices in intermediate goods input, and diversified intermediate goods input selection optimizes firms' production combinations through complementary matching while pushing firms toward intermediate goods with higher technical standards through competition effects, indirectly reflecting the level of firms' intermediate goods input quality. Concerning the measurement of intermediate goods input cost, the input factor price is the most direct manifestation of firms' input costs. The theoretical model also posits that the reduction in intermediate goods input cost primarily stems from declines in intermediate goods prices. Therefore, this paper selects the intermediate goods input price indicator as a proxy variable for intermediate goods input cost.

The regression results of the mechanism tests are detailed in Table 3. Columns (1) and (2) present the estimation results with the import quality of intermediate goods at the firm–product–destination country level and at the firm level as the explained variable, respectively. Column (3) reports the estimation results with the variety of intermediate goods input as the explained variable. The regression coefficients of firm-level deepening of FTA participation are all significantly positive, indicating that firms' utilization of FTAs enhances their intermediate goods input quality. Meanwhile, as a factor of production, intermediate goods input is absorbed into final goods during subsequent production processes. The embedded technology contained in intermediate goods exerts a decisive influence on the quality of final goods. Higher-quality intermediate goods and a wider variety of inputs provide stronger technical support and greater innovation space for firms' subsequent production processes, directly enhancing the technological sophistication and quality level of export products. Therefore, improvements in input quality indeed enhance the export product quality of final goods, confirming that intermediate goods input quality serves as a mechanism through which deepening of FTA participation impacts firm-level export product quality. Column (4) reports

the estimation results with firms' intermediate goods input price as the explained variable. The regression coefficient of firm-level deepening of FTA participation is significantly negative, indicating that firms' utilization of FTAs reduces intermediate goods input cost. Furthermore, the reduction in intermediate goods input cost not only increases the flexibility in firms' intermediate goods input and lowers the difficulty of adjusting product quality, but also frees up additional capital and managerial attention. This enables firms to reallocate saved resources toward improving product quality, strengthening brand building, and increasing R&D innovation, thereby enhancing resource allocation efficiency and ultimately boosting the competitiveness of export products. Consequently, reducing intermediate goods input cost enhances the export product quality of final goods, thus validating *H2*.

**Table 3**
*Regression Results of Mechanism Analysis*

| Variable | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| *fta* | 0.0155*<br>(0.009) | 0.3869***<br>(0.117) | 0.5855***<br>(0.214) | –2.7824***<br>(0.586) |
| Control variables | Control | Control | Control | Control |
| Firm/year/destination country/product fixed effect | Control | Control | Control | Control |
| Clustering level | Product | Product | Product | Product |
| *n* | 5,568,809 | 226,738 | 226,738 | 226,738 |
| $R^2$ | 0.3017 | 0.7561 | 0.7630 | 0.6668 |

*Note.* The explained variables in Columns (1) through (4) are the import quality of intermediate goods at the firm–product–destination country level, the import quality of intermediate goods at the firm level, the variety of firms' intermediate goods input, and the price of firms' intermediate goods input, respectively. Robust clustered standard errors are reported in parentheses.
*** $p < 0.01$, * $p < 0.1$.

### 5.2 Heterogeneity Analysis

Both the theoretical analysis and empirical test results above confirm that deepening of FTA participation promotes the upgrading of firm-level export product quality. Therefore, the focus of subsequent policy implementation lies in how to better leverage the positive role of deepening of FTA participation in enhancing export quality and transforming China into a trader of quality through scientific planning and policy guidance. This section attempts to examine the heterogeneous impact of deepening of FTA participation across different types of firms from the perspectives of institutional linkage intensity, international supply chain dependence, and high-level opening-up zones.

*5.2.1 Institutional Linkage Intensity*

Institutional linkage intensity directly affects firms' policy penetration efficiency through differences in rule internalization capabilities (for example, depth of understanding of FTA provisions, completeness of compliance management systems), thereby influencing the impact of deepening of FTA participation on quality upgrading. Particularly against the backdrop of the current complex and volatile international political and economic environment, firms with lower institutional linkage intensity are more susceptible to tariffs and non-tariff barriers, which , in turn, severely impact their export product quality. Therefore, examining the differential impact of deepening of FTA participation on export product quality under varying degrees of institutional embeddedness is of significant importance. Research by Qu and Yang (2024) indicates that state-owned enterprises, due to their governance synergy with policymakers (for example, participation in pilot free trade zones), exhibit significantly higher efficiency in absorbing FTA rules compared to non-state-owned enterprises. Based on this, this paper classifies state-owned enterprises as firms with high institutional linkage intensity ($Z = 1$) and non-state-owned enterprises as firms with low institutional linkage intensity ($Z = 0$), and constructs an interaction term between institutional linkage intensity and deepening of FTA participation (*sta_fta*) for regression analysis. As shown in Table 4, the positive impact of deepening of FTA participation on firm-level export product quality varies across firms with different levels of institutional linkage intensity. Specifically, the positive impact is stronger for state-owned enterprises with higher institutional linkage, while this positive impact for non-state-owned enterprises with weaker institutional linkage is not significant under deepening of FTA participation. This finding reflects that firms with institutional linkage advantages—namely, state-owned enterprises—are better positioned to effectively capitalize on the institutional dividends of FTA rules.

*5.2.2 International Supply Chain Dependence*

The degree of dependence on international supply chains exerts a significant influence on the upgrading of firm-level export product quality. For firms with higher dependence on international supply chains, further deepening of FTA participation can reduce trade barriers and costs, thereby more favorably promoting the upgrading of their export product quality. This is particularly evident among processing trade enterprises. Characterized by low value-added and high dependence, they typically occupy intermediate links in international supply chains and rely heavily on cross-border procurement and production networks. In contrast, general trade enterprises are less dependent on international supply chains, with their production relying more on domestic resources and markets. Consequently, the positive impact of deepening of FTA participation on their export quality is relatively modest. Accordingly, this paper defines processing trade enterprises as $Z = 1$ and general trade enterprises as $Z = 0$, and incorporates an interaction term (*dep_fta*) between the dummy variable for firms' international supply chain dependence and deepening of FTA participation

indicator. As shown in Table 4, the positive impact of deepening of FTA participation on firm-level export product quality varies across firms with different levels of international supply chain dependence. Specifically, the positive impact is stronger for processing trade enterprises with higher dependence on international supply chains, while the impact for general trade enterprises with lower international supply chain dependence is not significant.

#### *5.2.3 High-Level Opening-Up Zones*

High-level opening-up zones, represented by Comprehensive Bonded Zones and Free Trade Zones, serve as important windows for firms to access international factors and resources. Theoretically, firms located in high-level opening-up zones possess comparative advantages in terms of transportation infrastructure, policy support, and economic development levels, enabling them to acquire more diversified and high-quality resources and factors from around the globe. These firms already exhibit strong competitiveness in trade, and thus the positive impact of deepening of FTA participation on their export quality is limited. In contrast, for firms situated outside high-level opening-up zones, whose access to resources is relatively constrained, deepening of FTA participation can improve their export product quality and help compensate for their resource deficiencies. In view of this, this paper constructs a dummy variable $Z$ for high-level opening-up zones based on the years and cities designated for Comprehensive Bonded Zones and Free Trade Zones. Firms whose cities have been designated as high-level opening-up zones are defined as $Z = 1$; otherwise, $Z = 0$. An interaction term (*reg_fta*) between the dummy variable for high-level opening-up zones and deepening of FTA participation indicator is included in the regression. As shown in Table 4, the positive impact of deepening of FTA participation on firm-level export product quality varies depending on whether firms are located in high-level opening-up zones. Specifically, the impact is stronger for firms located outside high-level opening-up zones, while the impact for firms within high-level opening-up zones is not significant.

**Table 4**
*Regression Results of Heterogeneity Analysis*

| Variable | Institutional linkage intensity | International supply chain dependence | High-level opening-up zones |
|---|---|---|---|
| *fta* | 0.0439 | −0.1368*** | 0.1355*** |
| | (0.028) | (0.030) | (0.033) |
| *sta_fta* | 0.4922*** | | |
| | (0.190) | | |
| *dep_fta* | | 0.6682*** | |
| | | (0.046) | |

(*To be continued*)

(*Continued*)

| Variable | Institutional linkage intensity | International supply chain dependence | High-level opening-up zones |
|---|---|---|---|
| *reg_fta* | | | –0.1469*** |
| | | | (0.044) |
| Control variables | Control | Control | Control |
| Firm/year/destination country/product fixed effect | Control | Control | Control |
| Clustering level | Product | Product | Product |
| *n* | 5,568,809 | 5,568,809 | 5,568,809 |
| $R^2$ | 0.2661 | 0.2662 | 0.2661 |

*Note.* Robust clustered standard errors are reported in parentheses.
*** $p < 0.01$.

## 6 Extended Analysis: Structural Decomposition and Export Dynamics

### 6.1 Structural Decomposition of Export Product Quality

The preceding analysis has examined the positive impact of deepening of FTA participation on the quality of export trade at the micro level. Building on the aforementioned quality changes, this section decomposes industry-level export product quality from the perspective of firm entry and exit, and further investigates, from a dynamic evolution perspective, whether deepening of FTA participation impacts export product quality through structural changes within industries induced by resource reallocation. This paper treats each HS product code as an industry. Drawing on the firm dynamics theory of Griliches and Regev (1995), a four-dimensional decomposition model is constructed to decompose the change in industry-level export product quality into within-firm, between-firm, firm-entry, and firm-exit effects. Specifically, the within-firm effect refers to the industry-level quality change driven by incumbent firms' own quality upgrading under the condition of fixed market share, reflecting technological learning and process improvement at the firm level. The between-firm effect refers to the industry-level quality change induced by the reallocation of market shares under the constraint of constant quality levels, characterizing the market competition and selection mechanism. The firm-entry effect refers to new firms capturing market shares by virtue of their quality advantages and pushing back the frontiers of industry-level quality through creative destruction. The firm-exit effect refers to low-quality firms ceasing production due to market elimination, thereby raising the overall quality level of the industry. According to the definition of Griliches and Regev (1995), the resource reallocation effect is composed of the between-firm effect, firm-entry effect, and firm-exit effect, reflecting the market's dynamic optimization capability for production factors. It is noteworthy that the overall upgrading

of industry-level export quality primarily stems from within-firm technological upgrading and efficiency optimization driven by resource reallocation. Then, can deepening of FTA participation be achieved by promoting firms' investment in quality (within-firm effect) or accelerating the exit of inefficient firms (firm-exit effect)?

To address the above questions, the industry-level export product quality is first calculated as follows:

$$quality_{ft} = \sum_{i \in \Theta f} \omega_{it} \times quality_{it}. \tag{28}$$

In equation (28), $\Theta f$ represents the set of firms in industry $f$, and the weight $\omega_{it}$ is expressed by the export share of firm $i$ in industry $f$.

Subsequently, the dynamic decomposition identity for industry-level export product quality can be expressed as:

$$\begin{aligned}
\Delta quality_{ft} = & \sum_{i \in (H, EN)} \omega_{it} \times quality_{it} - \sum_{i \in (H, Ex)} \omega_{it-1} \times quality_{it-1} \\
= & \underbrace{\sum_{i \in (H)} \bar{\omega}_i \times (quality_{it} - quality_{it-1})}_{\text{within-firm effect}} \\
& + \underbrace{\sum_{i \in (H)} (\omega_{it} - \omega_{it-1}) \times (\overline{quality_i} - \overline{quality_f})}_{\text{between-firm effect}} \\
& + \underbrace{\sum_{i \in (EN)} \omega_{it} \times (quality_{it} - \overline{quality_f})}_{\text{firm-entry effect}} \\
& - \underbrace{\sum_{i \in (Ex)} \omega_{it-1} \times (quality_{it-1} - \overline{quality_f})}_{\text{firm-exit effect}}
\end{aligned} \tag{29}$$

In equation (29), $H$, $EN$, and $Ex$ denote the sets of continuing incumbents, entering firms, and exiting firms, respectively; $\overline{quality_i} = \frac{quality_{it} + quality_{it-1}}{2}$, $\overline{quality_f} = \frac{quality_{ft} + quality_{ft-1}}{2}$, and $\bar{\omega}_i = \frac{\omega_{it} + \omega_{it-1}}{2}$; the sum of the second, third, and fourth terms constitutes the generalized resource reallocation effect.

Based on the four-dimensional decomposition framework for industry-level quality constructed above, this paper specifies the following model to examine the impact of deepening of FTA participation on each decomposition component:

$$Q_{ft} = \varphi_0 + \varphi_1 fta_{ft} + \lambda_f + \lambda_t + \varepsilon_{ft}, \tag{30}$$

where $Q_{ft}$ represents the decomposed components obtained above, and $\lambda_f$ and $\lambda_t$ denote industry fixed effects and year fixed effects, respectively.

As shown in Table 5, the regression coefficient of the total effect of deepening of FTA participation is significantly positive, indicating that deepening of FTA participation

promotes product quality improvement. The regression coefficient of deepening of FTA participation on the within-firm effect is significantly positive, suggesting that deepening of FTA participation facilitates the product quality upgrading of incumbent firms. However, the regression coefficient on the between-firm effect is significantly negative, indicating that deepening of FTA participation inhibits quality changes arising from the redistribution of market shares. The regression coefficients on both the firm-entry effect and the firm-exit effect are significantly positive, demonstrating that deepening of FTA participation enhances export product quality through the survival-of-the-fittest effect in export markets. Further deepening of FTA participation intensifies competition among firms, leading to the exit of low-quality firms from the market while allowing firms specializing in high-quality products to enter the export market. At the same time, newly established specialized and sophisticated firms continuously enter the export market, whereas firms with lower sensitivity to new technologies gradually exit. Production efficiency and quality levels are continuously optimized and enhanced through this dynamic process of "creative destruction." Moreover, the impact of deepening of FTA participation on the resource reallocation effect is positive, indicating that deepening of FTA participation enhances export product quality through the resource reallocation effect.

**Table 5**

*Regression Results of Decomposition Effects*

| Variable | Total effect | Within-firm effect | Between-firm effect | Firm-entry effect | Firm-exit effect | Resource reallocation effect |
|---|---|---|---|---|---|---|
| *fta* | 0.1739*** | 0.0208*** | –0.0714*** | 0.2232*** | 0.0013*** | 0.1531*** |
| | (0.016) | (0.004) | (0.007) | (0.022) | (0.000) | (0.016) |
| Industry/year fixed effects | Control | Control | Control | Control | Control | Control |
| *n* | 43,060 | 43,060 | 43,060 | 43,060 | 43,060 | 43,060 |
| $R^2$ | 0.1048 | 0.2487 | 0.2345 | 0.1127 | 0.0555 | 0.1009 |

*Note.* Robust clustered standard errors are reported in parentheses.

*** $p < 0.01$.

### 6.2 Export Dynamics: Export Duration and Export Exit

The preceding export structural decomposition has, from a dynamic perspective, indicated that deepening of FTA participation triggers a screening mechanism for export products at the meso level through the market entry of high-quality firms and the exit of low-quality firms, manifesting a survival-of-the-fittest effect characterized by structural optimization. In fact, the research paradigm of international trade dynamics incorporates trade relationship persistence into its analytical framework. This indicator not only constitutes a core element

of intensive margin growth but also influences the evolutionary path of trade through a stability transmission mechanism. Therefore, this paper further validates the survival-of-the-fittest effect derived from the structural decomposition above from the dynamic perspective of firm export duration, examining whether the duration of firms' export behavior shows an improving trend under the policy background of deepening institutional trade agreements.

First, according to the theoretical framework of survival analysis, this paper defines firm export duration as the time span (measured in years) from a specific market entity's first realization of trade access to its complete withdrawal from the target market (subject to the condition of continuous export activity). Within this methodological system, the termination of export behavior by a firm is regarded as a risk event in survival analysis. It is worth noting that data processing requires addressing two issues. The first is the correction of data censoring. When employing the survival analysis model to examine firm export duration, both left censoring and right censoring arise. To address left censoring, this paper draws on the approach of Mao and Xu (2014) and focuses on firms with no export activities during the initial period but with export activities in subsequent periods. For right censoring, the survival analysis model can resolve it autonomously. The second concerns multiple duration spells. In international trade, firms may undergo a dynamic process of entering the export market, continuing to export, temporarily exiting, and then re-entering. To accurately capture such discontinuous export behavior, this paper adopts the discretization method proposed by Chen et al. (2012), treating discontinuous export cycle structures within the same trade relationship as independent observation periods. This method effectively resolves the difficulty of segmenting duration spells caused by intermittent market interruptions, laying the foundation for subsequent survival analysis.

Second, this paper divides the sample data into firms with high export product quality (*high_quality=1*) and firms with low export product quality (*high_quality=0*) according to the median of firm-level export product quality, and plots the survival curves of firm export duration. As shown in Figure 3, the survival curve for the firm group with high export product quality is generally located above that for the firm group with low export product quality, indicating that the export duration of high-quality products is relatively longer.

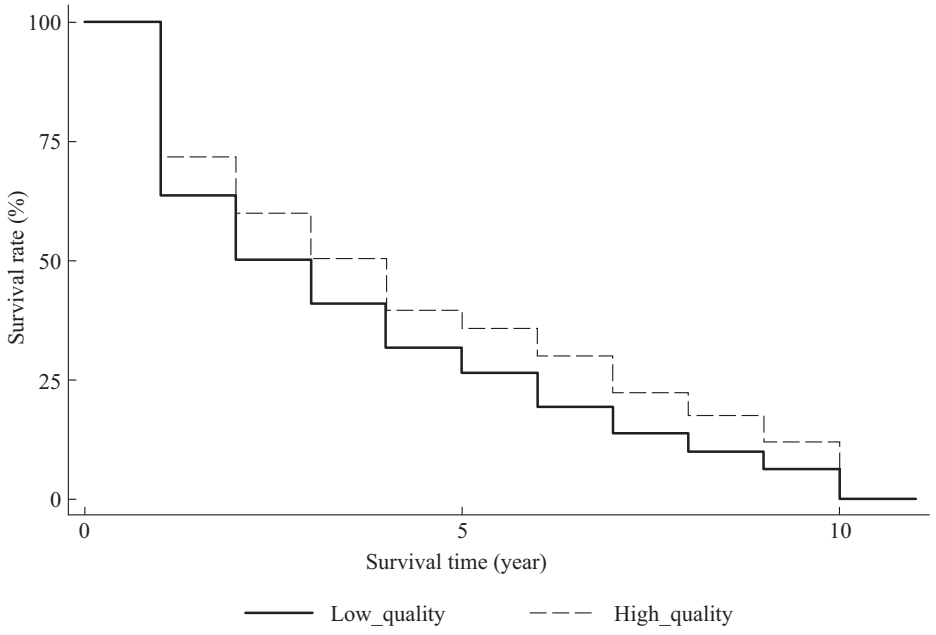
Furthermore, this paper employs the Cox proportional hazards model to assess the impact of deepening of FTA participation on firm export duration. The model is specified as follows:

$$Cox(1-h_{it}) = \kappa_0 + \kappa_1 fta_{it} + \kappa \vec{X}_{it} + h_{0t} + \lambda_i + \lambda_t + \varepsilon_{it}, \tag{31}$$

where $h_{it}$ represents the discrete-time hazard rate, $h_{0t}$ denotes the baseline hazard rate, and $\vec{X}_{it}$ is a vector of control variables. The PH model is also employed for robustness checking. As shown in Table 6, deepening of FTA participation significantly increases the hazard rate of firms exiting export markets, thereby reducing firm export duration. This finding is consistent with the survival-of-the-fittest effect derived from the structural decomposition.

Moreover, firms with significant advantages in export product quality tend to have longer export duration cycles. This raises a critical question: Can firms effectively extend their

**Figure 3**
*Survival Curves*




export duration by implementing product quality upgrading strategies? This paper further incorporates the interaction term between the export product quality dummy variable (*high_quality*) and the firm-level deepening of FTA participation into equation (31). As shown in Table 6, the regression coefficient of the interaction term is significantly negative, indicating that in the process of deepening of FTA participation, quality upgrading strategies exert an inhibiting effect on firms' exit from export markets. This verifies the positive role of quality optimization in extending firm export duration.

**Table 6**
*Estimated Regression Results of the Impact of Deepening of FTA Participation on Export Duration*

| Variable | Cox estimation | PH estimation | High-quality interaction effect (Cox) | High-quality interaction effect (PH) |
|---|---|---|---|---|
| *fta* | 0.0574* | 0.1252*** | 0.2492*** | 0.4350*** |
| | (0.032) | (0.044) | (0.047) | (0.066) |
| *high_quality* × *fta* | | | –0.4039*** | –0.6447*** |
| | | | (0.062) | (0.085) |

(*To be continued*)

(*Continued*)

| Variable | Cox estimation | PH estimation | High-quality interaction effect (Cox) | High-quality interaction effect (PH) |
|---|---|---|---|---|
| Control variables | Control | Control | Control | Control |
| Year fixed effect | Control | Control | Control | Control |
| *n* | 251,938 | 251,938 | 251,938 | 251,938 |

*Note.* Robust clustered standard errors are reported in parentheses.
*** $p < 0.01$, * $p < 0.1$.

## 7 Conclusions and Implications

This paper utilizes the product–export destination country data from 2005 to 2015. Based on the preferential tariff rates stipulated in the FTAs and the FTA utilization rates published by the GACC in 2013, it calculates the utilization rates of various FTAs signed by China. Furthermore, it measures firm-level FTA utilization rates using the Chinese Customs Database to represent deepening of FTA participation, and further examines its impact on firm-level export product quality and the underlying mechanisms. The main findings of this paper are as follows: Firstly, deepening of FTA participation improves firm-level export product quality. This conclusion remains robust after a series of endogeneity tests (for example, using the instrumental variable approach) and robustness checks (for example, replacing variables and adjusting sample observation periods). Secondly, deepening of FTA participation impacts firm-level export product quality through intermediate goods input quality and intermediate goods input cost. Thirdly, the positive impact of deepening of FTA participation on export product quality exhibits significant asymmetry across different types of firms. Specifically, the positive impact is stronger for firms with higher institutional linkage intensity, greater dependence on international supply chains, and those located outside high-level opening-up zones. Fourthly, the improvement in export product quality is primarily achieved through an intra-industry structural effect driven by the exit of low-quality products from the market and the entry of high-quality products. Building on this, the paper employs a survival analysis model and finds that while deepening of FTA participation increases the hazard rate of firms exiting export markets, it can relatively extend export duration by improving product quality. Overall, deepening of FTA participation generates a survival-of-the-fittest effect.

Based on the above conclusions, this paper proposes the following policy implications: Firstly, having secured FTA negotiations and signings, the government can actively promote the full implementation of FTA policies. It is advisable to adopt differentiated measures based on firm characteristics such as ownership, trade modes, and regional location. This approach can orderly and steadily guide firms in utilizing FTAs to adjust their export markets and product strategies, thereby optimizing global supply chain layouts. Specifically,

the government can organize comprehensive FTA policy briefings and training activities. These initiatives help firms gain a deeper understanding of FTA preferential tariff policies and usage rules. Additionally, establishing an information-sharing platform for firms to provide the latest FTA updates, case analyses, and successful experiences can ensure that firms effectively leverage FTAs to reduce costs and improve product quality. Secondly, it is important to foster firms' technological R&D and absorption capabilities to fully harness the technology spillover effects stemming from deepening of FTA participation. The government can support technological innovation and process improvement through financial subsidies and tax incentives to help firms enhance their product quality. At the same time, promoting technical exchanges and cooperation within industries and building technology innovation platforms enable firms to access more advanced production technologies and management expertise. This, in turn, boosts the competitiveness and quality of their export products. Thirdly, it is recommended to encourage firms to optimize and diversify their supply chains. Policy guidance and financial support can facilitate their collaboration with high-quality suppliers both domestically and internationally, mitigating supply chain risks facing them. Offering preferential loans, risk guarantees, and technical assistance helps firms explore new supply channels, strengthening their resilience to risks. Furthermore, encouraging firms to prioritize quality and service when selecting suppliers fosters stable supply relationships, ensuring a consistent supply of high-quality products. Fourthly, it is essential to establish a quality product development fund and strengthen monitoring mechanisms for export dynamics. These measures promote industrial structure optimization and the introduction of high-quality products, supporting firms in selecting better products for export. At the same time, encouraging firms to pursue differentiated competition in their export products, along with providing market development funds and risk guarantees, can reduce their dependence on a single market. This approach ensures firms' stable growth amid volatile international markets, ultimately enhancing their overall export product quality and market competitiveness.

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