Discussion Paper Series – CRC TR 224

Discussion Paper No. 533
Project B 06

Diversification or Specialization? The Responses of Multi-Product Exporters to Quota Removal

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April 2024

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Support by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) through CRC TR 224 is gratefully acknowledged.

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March 2024

Abstract

This paper investigates how multi-product firms narrow their product scope and target fewer export destinations in response to increased demand. Focusing on the effects of quota removal, we show that an increase in demand for quota-bound products crowds out quota-free products through cannibalization, and reduces exports to quota-free destinations through capacity constraint. Consistent with the theory, our findings reveal a 25% increase in product concentration and a 2% increase in destination concentration among Chinese exporters after the removal of externally imposed quotas on textile and clothing exports. The increasing concentration is due to the export shifts from quota-free to quota-bound products and destinations. Subsequently, affected firms exhibit better capital market performances, with a 5% higher abnormal return within the three-day event window.

Keywords: import quota, multi-product firms, cannibalization effect, diversification, demand linkages, supply linkages, exports, stock market

JEL: F12, F13, F14,

Supports by the National Natural Science Foundation of China under grant No. 71871234 and the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) through CRC TR 224 (Project B06) are gratefully acknowledged.

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1 Introduction

Trade activities are predominantly carried out by a small number of multi-product firms (MFPs) that can flexibly make intra-firm adjustments with respect to scale and scope. In response to trade liberalization, such as tariff cuts, MPFs adjust their product scope and skew sales towards their core competencies (e.g., Eckel and Neary 2010; Bernard et al. 2011). However, less is known about the impact of import quotas, a commonly used trade policy tool, on firms' export behaviors. Furthermore, there is a limited understanding of how and to what extent demand and supply forces contribute to MPFs' intra-firm adjustments, with a few exceptions (e.g., Eckel et al. 2023).

In this paper, we explore how—through *demand and supply linkages*— multi-product firms make intra-firm adjustments to their product lines and target markets in response to quota removal. We extend the multi-product firms model by Eckel and Neary (2010), integrating market segmentation and pricing-to-market decisions from Atkeson and Burstein (2008), to encompass a spectrum of trade barrier changes beyond the binary scope of globalization (autarky vs. free-trade). In addition, we add another margin of adjustment by allowing exporters to have multiple heterogeneous destinations. The analysis of the heterogeneity in the export adjustments across products and destinations with detailed Chinese export data enables us to differentiate between the demand and supply forces.

Our analysis begins with a theoretical examination of how the elimination of destination-product-specific quotas affects the export scale and scope of MPFs. In the model, one destination country imposes quotas on some products of MPFs to protect its domestic firms, while the other destination country is unrestricted. When the quota constraint is relaxed, it influences MPFs' diversification strategies on both demand and supply sides. On the demand side, market size and cannibalization effects can exert an influence. The former is directly expressed as a uniform increase in exports of quota-bound products, and the latter decreases the exports of all quota-free products equivalently. The above two effects collectively lead to an intra-firm export shift to quota-bound products. On the supply side, an increase in equilibrium wages due to quota removal imposes a capacity constraint, pushing MPFs to concentrate on their core competencies and abandon marginal varieties.[1] The capacity constraint effect decreases MPFs' export scale and narrows the product scope in the quota-free country and generates an export shift towards the quota-bound country.

The model underscores three critical aspects to grasp the interplay of demand and supply dynamics. First, the demand forces of quota removal lead to an equivalent decrease (increase) in the exports of quota-free (quota-bound) products, regardless of whether the production of the product is efficient or not.[2] Second, the cost increase arising from the capacity constraint is more pronounced for less

[1]A product is defined based on the 8-digit HS product codes, and a variety refers to a firm-product pair.

[2]Efficiency is defined based on the marginal cost. The production of more efficient products requires fewer inputs

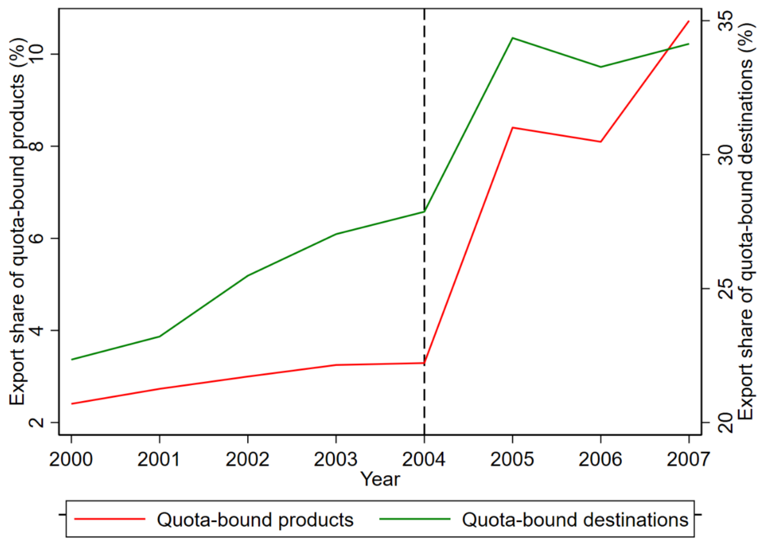

Figure 1: The export shares of quota-bound products and destinations

Notes: This figure presents the export shares of quota-bound products and destinations before and after quota removal. China's exports of textiles and clothing to the United States, the European Union, Canada, and Turkey were limited by quotas before January 1, 2005. The product-country pairs subject to quotas before 2005 are referred to as "quota-bound", while others are "quota-free". Turkey is excluded from the analysis due to the absence of its quota lists and its minor contribution to China's exports.
Source: Authors' calculation based on quota lists from the Multifiber Arrangement and export data from China Customs.

efficient products, regardless of which destination the product is supplied to. Third, the capacity constraint generates a spillover effect on exports to quota-free countries while the demand forces are only present in quota-bound destinations. Thus, demand force plays an important role in heterogeneous export responses across destinations, while supply force matters for heterogeneity in export adjustments across products and cross-country spillovers.

We empirically test the above theoretical predictions in the context of the phase-out of the Multifiber Arrangement (MFA). Under the MFA, textile and clothing exports from China and other developing countries to the United States, the European Union, Canada, and Turkey were subject to quotas before January 1, 2005. Given China's large export volume and active participation in global textile trade over the past few decades, this provides us with a good setting to test the impact of quota removal. As shown in Figure 1, the quota removal did have a substantial influence on Chinese exporters' product mix and destinations. On average, the export share of quota-bound products and quota-bound destinations increased by 5% and 6% from 2004 to 2005, respectively.

We rely on detailed firm-product-destination-level export data from China Customs for 2000–

and thus has lower marginal costs.

2007 and use difference-in-differences (DID) specifications to identify the effects of quota removal. Products and destinations are categorized as quota-bound or quota-free, depending on whether they were subject to quotas before 2005. We capture the product diversification of MPFs through three commonly used measures, namely the number of export products (i.e., scope), the Herfindahl index (HI), and the entropy index (EI). Measures of destination diversification are constructed analogously. A higher (lower) HI (EI) indicates that exports are more concentrated across products or destinations.

To start, we investigate how the quota removal alters the product mix of multi-product firms. There are three main empirical findings. First, quota removal leads to a substantial decrease in product-based export diversification. Specifically, a firm's number of products exported to a given destination decreases by 11% after quota removal, and the corresponding HI (EI) increases (decreases) by 25% (72%). Second, the reduction in product scope is associated with a skewed product mix toward quota-bound products. After quota removal, the share of quota-bound products exhibits a 3% increase in exports to a specific quota-bound destination. The number increases slightly when we control for the supply force. Third, we find heterogeneous responses of core and marginal varieties, affirming the presence of the capacity constraint effect. The export expansion of quota-bound products is dominated by MPFs' core varieties.

Next, we investigate how MPFs adjust their exports across destination markets in response to quota removal. We find that quota removal leads to lower destination diversification, where there are a 9% decrease in the number of firms' export destinations, a 2% increase in HI, and a 21% decrease in EI. Furthermore, the decrease in destination diversification is accompanied by an export shift from quota-free to quota-bound countries. The export to quota-bound countries as a share of total export increases by 2% after quota removal. We also study the spillover effect on non-textile products and non-OECD countries. Specifically, the exports of non-textile products to non-OECD countries experience a statistically significant declines in both the intensive and extensive margins, supporting the presence of the supply force.

Furthermore, we address the potential concern that our results might be driven by the rectification of quota license misallocations. As shown in Khandelwal et al. (2013), state-owned enterprises (SOEs) were given priority in China's quota allocation and lost market share after quota removal as more productive private firms entered. This introduces two plausible alternative explanations for our main findings. First, new entrants have fewer products and destination markets than incumbents, lowering the average degree of diversification. To address this concern, we restrict the sample to SOEs and find SOEs to be more specialized after quota removal. Second, tougher competition from productive private entrants forces MPFs to skew towards their core competencies (Mayer et al. 2014). We assess firms' susceptibility to competition based on the changes in their market shares and find statistically indistinguishable changes in specialization for incumbents more or less affected by tougher competition.

Lastly, we investigate the impact of quota removal on firms' stock market performance. We link the detailed export transaction data with the Chinese stock market transaction data and identify whether a listed firm is affected by quota removal based on its export product and destination mix. After calculating abnormal returns through the FF-5 model (Fama and French 2015), we find that quota removal leads to a 5% increase in abnormal returns of affected firms within the three-day event window around the announcement date. This finding indicates that specialization induced by quota removal has a positive effect on MPFs' expected profits in the future.

Our theoretical framework builds on the workhorse model of MPFs proposed by Eckel and Neary (2010), who explore the impact of globalization on firms' export scale and scope. There are two main extensions in our paper. First, we extend the multi-product firms model by Eckel and Neary (2010), incorporating market segmentation and pricing strategies from Atkeson and Burstein (2008), thereby addressing a broader spectrum of trade barrier modifications beyond the binary scope of autarky versus free trade. Second, we introduce an additional adjustment margin, namely export destination, and consider intra-firm adjustments across products and destinations. With the above extensions, we are able to explore the heterogeneity in the export adjustments across products and destinations, thereby differentiating between demand and supply forces.

Recent theoretical studies have explored the role of demand or supply linkage that generates spillover effects across products and destinations within MPFs. The first strand of literature studies the demand linkages arising from product substitutability or complementarity (Eckel and Neary 2010; Bernard et al. 2011; Dhingra 2013; Mayer et al. 2014; Nocke and Yeaple 2014), which generates the cannibalization and competition effects. In our model, we account for the cannibalization effect while abstracting away the competition effect, as the empirical findings suggest that the magnitude of the competition effect is rather small. The second strand of literature focuses on supply linkages arising from the economics of scope (Bernard et al. 2011; Arkolakis et al. 2021) and input sharing across products within MPFs (Eckel and Neary 2010). Our paper proposes the capacity constraint effect of quota removal based on Eckel and Neary (2010). In the literature, few papers have worked on combining the above two strands of literature and exploring the joint effect of the two forces. One exception is Eckel et al. (2023) who focus on antidumping duties and show the existence of cannibalization linkages in presence of supply linkages. We contribute to the literature by (i) building a theoretical framework incorporating the interaction between these two types of linkages, and (ii) empirically quantifying the respective role of demand and supply forces as they exert different influences on products and destinations. In addition, we obtain two interesting implications from the model. (i) The effects of quota removal depend on the initial level of trade barriers. (ii) MPFs adjust the scope of quota-bound and quota-free products differently, depending on whether quotas are imposed on their core or marginal varieties.

Our paper is also related to the growing empirical literature on MPFs' responses to trade liberalization or protectionism (Baldwin and Gu 2009; Iacovone and Javorcik 2010; Bernard et al. 2011; Mayer et al. 2021; Albornoz et al. 2021; Bao et al. 2021). We complement this literature mainly in two ways. First, existing studies use changes in tariffs as the exogenous shock, whereas quota, another form of trade barrier, has received little attention. Additionally, the quotas in this paper are product-destination-specific, which provides a perfect setting to explore the intra-firm linkages across products and destinations. Second, we utilize detailed export transaction data to provide evidence of export diversification on multiple dimensions.

The rest of the paper proceeds as follows. Section 2 details the institutional setting of the quota removal policy and presents novel facts on Chinese exporters that motivate our model. Section 3 introduces a theoretical framework of how quota removal causes MPFs to adjust their exports across products and destinations through demand and supply linkages, which is used to guide the empirical analysis. Section 4 provides details on the data and variable construction. Section 5 presents our main empirical results and discusses two alternative explanations for our results arising from quota misallocation. Section 6 explores the impact of quota removal on firms' stock market performance. Finally, Section 7 concludes.

2 Background

2.1 Multifiber Arrangement

The textile and clothing industry is particularly important in China's manufacturing, and its exports from China contribute substantially to global trade. After China's accession to the World Trade Organization (WTO) in 2001, its textile and clothing exports accounted for 13% of the world's total, amounting to $54 billion. By 2010, the share of China's exports in total global exports had risen to 34%, and its export value reached $212 billion, securing China's position as the world's leading textile exporter.

However, the export quantity of these products was restricted by trade barriers imposed on China before 2005. Specifically, the MFA employed quotas as a tool to manage the international textile trade. The exports of textile products from China and other developing countries to the United States, the European Union, Canada, and Turkey were subject to quotas as a form of bilateral non-tariff barrier. These quotas were independent of the WTO and were scheduled to be eliminated in four stages from the conclusion of the Uruguay Round in 1995 until 2005. Before joining the

WTO in 2001, China maintained quotas on goods from Phases I, II, and III. These quotas were eliminated on January 1, 2002, in accordance with the scheduled Phase III removal date. In addition, developed countries tended to defer the elimination of quotas on "sensitive" products until the final phase, as they had the ability to choose how to allocate the order of products for quotas retired in each phase (Brambilla et al. 2010). It should be noted that the lists of products subject to quotas were determined in 1995, which are absolutely exogenous for firms' exports during our sample period. To appreciate the magnitude of the quota elimination, we focus on the final phase, which took effect on January 1, 2005, covering the remaining 49% of import volumes in 1990 from the developed countries mentioned earlier.

We divide the product-destination pairs into "quota-bound" and "quota-free" groups based on the lists of products subject to quotas. The product-destination pairs subject to quotas prior to 2005 are classified as "quota-bound", while the rest are referred to as "quota-free". This means that each 8-digit Harmonized System (HS) product in our sample is categorized as either quota-bound or quota-free based on its export destination. Given the lack of product lists covered by quotas in Turkey and its negligible share in China's textile exports, we exclude it from our analysis. The European Union is treated as a single block of countries since quotas are established for the union as a whole. Henceforth, a product is defined based on the 8-digit HS codes, and a variety refers to a firm-product pair.

2.2 Stylized Facts

In this section, we document three stylized facts about China's textile quotas and export firms to guide our theoretical framework about how quota removal affects firms' export strategies. These facts are found based on the rich export data collected by China Customs, which will be detailed in Section 4.1.

Fact 1. *A large fraction of exporters are multi-product and multi-destination firms.*

Similar to the prevalence of MPFs in developed countries (Bernard et al., 2011), we find that 87% of Chinese textile exporters in 2004 exported multiple products, and 71% exported to multiple destinations. Meanwhile, multi-product exporters also tend to be multi-destination exporters. Among Chinese textile exporters, 67% exported more than one product to more than one destination. Furthermore, conditional on firms exporting at least one quota-bound product, the share of multi-product exporters is much higher at 97%, with 51% of firms exporting five or more products to more than five destinations. These statistics demonstrate that multi-product and multi-destination firms are very prevalent in China's textile export market.

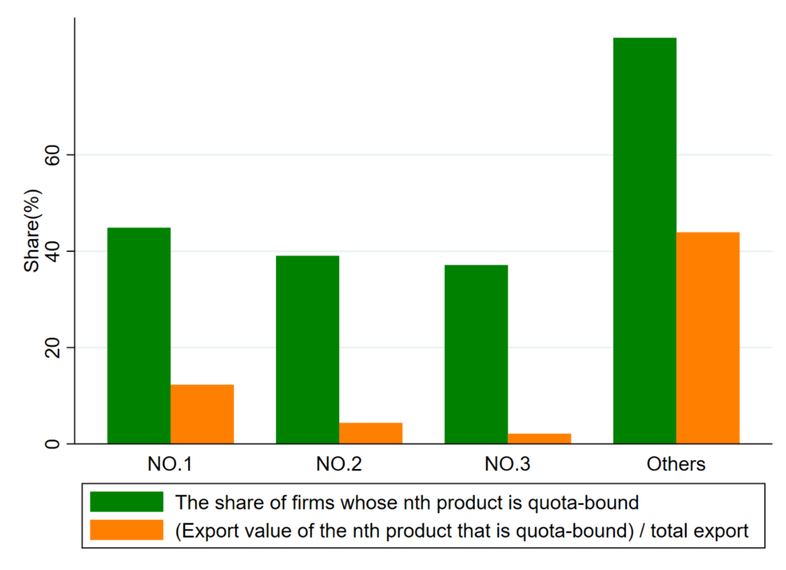

Figure 2: Share of firms exporting quota-bound products

Notes: This figure presents the share of firms exporting quota-bound products before 2005. For each firm, we rank all their products based on export value in 2007, where No.n is the nth largest product and others are products beyond the 3th. We restrict the sample to Chinese exporters who exported at least one quota-bound product. The green bars display the share of firms whose No.n product was subject to quotas before 2005. The orange bars represent the corresponding export share, namely the export value of quota-bound products as a share of the total exports of all firms in the sample.

Source: Authors' calculation based on quota lists from the Multifiber Arrangement and export data in 2007 from China Customs.

Fact 2. *Quotas are product-destination specific.*

Whether the export of a product is subject to quotas depends upon its export destination. China's textile exports to the United States, the European Union, Canada, and Turkey were regulated before 2005, while exports to other countries were not. Meanwhile, not all of the textile products exported to the above destinations are in quota lists. In 2004, quota-bound products accounted for 46%, 27%, and 25% of China's textile exports to the United States, the European Union, and Canada, respectively.

Fact 3. *Both core and marginal varieties are likely to be subject to quota restrictions.*

Figure 2 illustrates whether the probability of different varieties (firm-product pairs) being subject to quotas depends on their production efficiency. Whether a variety is produced efficiently is identified by its share in the firm's exports in 2007.[3] Higher export share means higher efficiency.

[3] As shown in Figure 3 of Section 3, the exports of different varieties within a firm can be used to identify the firm's efficiency in producing each product in the absence of quota restrictions.

45% of the firms have their No.1 products subject to quotas, and the major products account for 12% of the total export values of these firms. For all products outside the top three, quota-bound products account for 44% of total exports. The findings suggest that both core and marginal products can be subject to quotas.

3 Theoretical Framework

Motivated by stylized **Fact 1**, we present a monopolistic equilibrium model of multi-product and multi-destination firms based on Eckel and Neary (2010) in this section. We introduce pricing-to-market decisions in Atkeson and Burstein (2008) to explore the intra-firm adjustments across products and destinations. Eckel and Neary (2010) model the effects of globalization on MPFs' scale (intensive margin) and scope (intra-firm extensive margin) under two extreme cases, namely autarchy and free trade. Specifically, they assume each identical country is either a closed economy or integrated into a free-trading world market. We expand the two extreme cases to study continuous changes in quotas. The key insight is that MPFs optimize export strategies by destination subject to destination-product-specific quota restrictions (**Fact 2**) rather than treating all countries as an integrated market.

3.1 Demand

We focus on the export strategies of MPFs in origin country o. A representative exporter supplies differentiated varieties to two segmented destination markets, of which one is a quota-bound country (indexed by $c = 1$) and the other is a quota-free country (indexed by $c = 2$). There are L_c consumers with identical preferences in country c. The preference of a representative consumer is a two-tier utility function as in Eckel and Neary (2010). Consumers in different countries have the same utility function. We omit the destination subscript c for simplicity when analyzing individual utility in Eqs. (1)-(3). Aggregate utility U is summed by the sub-utility $u\{z\}$ of a continuum of industry for $z \in [0, 1]$:

$$U\left[u\{z\}\right] = \int_0^1 u\{z\}dz. \tag{1}$$

For a given industry z, the utility function $u(z)$ has the feature of "love of variety":

$$u(z) = a\int_0^N q(i)di - \frac{1}{2}b\left[(1-e)\int_0^N q(i)^2 di + e\left\{\int_0^N q(i)di\right\}^2\right], \tag{2}$$

where $q(i)$ is the quantity consumed and $i \in [0, N]$. N is the measure of differentiated goods in each industry z. Non-negative parameter a captures the consumer's maximum willingness to pay, and b denotes the individual demand slope. Parameter $e \in (0, 1)$ inversely measures product differentiation. Consumers maximize their utility subject to the budget constraint: $\int_0^1 \int_0^N p(i)q(i) \leq I$, where I denotes the individual income. The first-order condition gives the individual inverse demand function for variety i:

$$\lambda_I p(i) = a - b \left[(1-e)q(i) + e \int_0^N q(i)di \right]. \tag{3}$$

where $p(i)$ denotes the price of variety i, and λ_I is Lagrange multiplier of budget constraint. The aggregate demand $x_c(i)$ for variety i of country c is equal to $L_c q(i)$. The inverse aggregate demand function for variety i in country c can be written as:

$$p_c(i) = a^{'} - b_c^{'} \left[(1-e)x_c(i) + eY_c \right], c = 1, 2, \tag{4}$$

where $a^{'} \equiv a/\lambda_I$, $b_c^{'} \equiv b/\lambda_I L_c$, $p_c(i)$ is the market price of variety i in country c, and $Y_c \equiv \int_0^{N_c} x_c(i)di$ denotes country c's total consumption of goods in the given industry. Consumers in different countries are deemed to have the same income levels and preferences, so differences in aggregate demand can only arise from the population size.

3.2 Supply

There are m symmetric MPFs in origin country o that supply goods to countries 1 and 2. The supply side of MPFs is characterized by flexible manufacturing and core competence. Let $c_j(i)$ denote the marginal cost of firm j producing variety i. We assume that the marginal cost is constant with respect to quantity but varies across varieties. The core competence is the most efficient variety with the lowest marginal cost, set at $i = 0$ with $c_j(0)$. Flexible manufacturing allows the firm to make some additions to its product line along with its core competence. $c_j(i)$ rises as variety i moves away from the core competence, and each new variety addition will incur a higher marginal cost.

We assume that labor is the only input factor. The labor market is perfectly competitive, and labor is immobile across countries. Firm j needs $\gamma_j(i)$ units of labor to produce one unit of variety i. Given the wage w, the marginal cost of variety i can be represented as $c_j(i) = w\gamma_j(i)$. Unit labor input $\gamma_j(i)$ is a strictly increasing function of product variety i: $\frac{\partial \gamma_j(i)}{\partial i} > 0$. Additionally, any firm wishing to export products to country c has to pay a fixed cost of f_c units labor. The fixed cost is independent of the scale and scope decisions. Therefore, for simplicity, we omit the firm subscript j henceforth.

3.3 Export Strategies

The m symmetric MPFs in origin country o face an aggregate quota when exporting to country 1. The lists of quota-bound products and the quota amount are determined exogenously through bilateral negotiations between countries. Motivated by stylized **Fact 3**, we consider two situations in which quotas are imposed on core or marginal varieties, respectively. In our main analysis, we focus on the former, i.e., country 1 imposes quotas on core varieties of MPFs from the origin country to protect its domestic firms.[4] The range of quota-bound products is denoted by $[0, \delta^*]$. $\delta^* > 0$ is determined exogenously, and the optimal possible exports of variety δ^* without quotas are positive, indicating that country 1 officially imposes quotas on only some, but not all, of MPFs' export products (**Fact 2**). The total exports of all quota-bound products are limited to no more than Q, and the total quota Q is evenly distributed to m symmetric exporters. Thus, the quota for each MFP is $\frac{Q}{m}$, that is $\int_0^{\delta^*} x_1(i) \leq \frac{Q}{m}$. The product varieties after δ^* are exported to country 1 free of quotas. All products are exported to country 2 without any restrictions.

We assume that MFPs play a single-stage Cournot competition. Each firm's objective is to maximize its profits by setting both the destination-specific scope and scale. Let δ_2 denote the scope of products exported to country 2. When exporting to country 1, the firm needs to simultaneously choose the export scope of quota-bound and quota-free products, The former is denoted by δ_1^b, and the latter is denoted by δ_1^f. The profit maximization subject to quota constraints of a representative MFP exporting to countries 1 and 2 can be written as:

$$\begin{aligned} max\ \Pi = & \int_0^{\delta_1^b} [p_1(i) - w\gamma(i)]\, x_1(i)di + \int_{\delta^*}^{\delta_1^f} [p_1(i) - w\gamma(i)]\, x_1(i)di - wf_1 \\ & + \int_0^{\delta_2} [p_2(i) - w\gamma(i)]\, x_2(i)di - wf_2 \\ s.t. & \int_0^{\delta_1^b} x_1(i) \leq \frac{Q}{m} \\ & \delta_1^b \leq \delta^*. \end{aligned} \tag{5}$$

The Lagrangian function can be written as $L = \Pi + \lambda_Q \left[\frac{Q}{m} - \int_0^{\delta_1^b} x_1(i)di\right] + \lambda_\delta \left[\delta^* - \delta_1^b\right]$, where $\lambda_Q \geq 0$ is the Lagrangian multiplier with respect to the quota constraint and $\lambda_\delta \geq 0$ is the Lagrangian multiplier with respect to the exogenous range of quota-bound products. λ_Q reflects the increase in (maximum) profits when the quota constraint is relaxed and can be explained as

[4] The framework in which quotas are imposed on marginal varieties can be found in Appendix 8.3.

the shadow price of the quota. The first-order conditions of the profit maximization problem in Eq. (5) with respect to the export scale of quota-bound and quota-free products to country 1 are listed as follows:

$$\frac{\partial L}{\partial x_1(i)} = p_1(i) - w\gamma(i) - b_1^{'}\left[(1-e)x_1(i) + eX_1\right] - \lambda_Q = 0, i \in \left[0, \delta_1^b\right], \tag{6}$$

$$\frac{\partial L}{\partial x_1(i)} = p_1(i) - w\gamma(i) - b_1^{'}\left[(1-e)x_1(i) + eX_1\right] = 0, i \in \left[\delta^*, \delta_1^f\right]. \tag{7}$$

$X_1 \equiv \int_0^{\delta_1^b} x_1(i)di + \int_{\delta^*}^{\delta_1^f} x_1(i)di$ is the firm's total exports to country 1, where the first term on the right side is the total exports of quota-bound products (denoted by X_1^b) and the second term is the total exports of quota-free products (denoted by X_1^f). Combining Eqs. (4), (6) and (7), the export of a given quota-bound or quota-free variety is given by:

$$x_1(i) = \frac{a^{'} - w\gamma(i) - \lambda_Q - b_1^{'}e(Y_1 + X_1)}{2b_1^{'}(1-e)}, i \in \left[0, \delta_1^b\right], \tag{8}$$

$$x_1(i) = \frac{a^{'} - w\gamma(i) - b_1^{'}e(Y_1 + X_1)}{2b_1^{'}(1-e)}, i \in \left[\delta^*, \delta_1^f\right]. \tag{9}$$

As we can see, the total exports of the firm X_1 reduce the export of a given variety. This reflects the cannibalization effect of MPFs and arises from internalizing demand linkages between the firm's produced varieties. Y_1 is the industry aggregate consumption in country 1, which includes the exports from origin country o to destination country 1, exports from other countries, and the output of the domestic firms in country 1. We further assume the products from origin country o do not influence the industry aggregate consumption in country c (Y_c) for simplicity.[5] Under this assumption, we ignore the competition effect between firms and focus on how the removal of quota works through the cannibalization effect within firms.

The first-order conditions with respect to the export scope of quota-bound and quota-free products to country 1 are given by:

$$\frac{\partial L}{\partial \delta_1^b} = \left[p_1(\delta_1^b) - w\gamma(\delta_1^b) - \lambda_Q\right] x_1(\delta_1^b) - \lambda_\delta = 0, \tag{10}$$

$$\frac{\partial L}{\partial \delta_1^f} = \left[p_1(\delta_1^f) - w\gamma(\delta_1^f)\right] x_1(\delta_1^f) = 0. \tag{11}$$

[5]The assumption of constant aggregate consumption ($dY_c = 0$) is consistent with the constant income of country c's consumers in Eq. (4), where we take λ_I as given. The simplicity assumption allows us to ignore the strategic interactions between firms and focus on intra-firm adjustments.

The complementary slackness conditions for the two constraints are:

$$\lambda_Q \left[\frac{Q}{m} - \int_0^{\delta_1^b} x_1(i)di \right] = 0, \tag{12}$$

$$\lambda_\delta \left[\delta^* - \delta_1^b \right] = 0. \tag{13}$$

The intuition behind Eqs. (12) and (13) is that λ_Q and λ_δ measure to what extent the corresponding constraint limits the growth of the objective function. If the quota (scope) constraint is slack at optimal, then the constraint does not work at all, and we will have $\lambda_Q = 0$ ($\lambda_\delta = 0$).

3.4 Partial Equilibrium

In this section, we consider three cases based on λ_δ and λ_Q.

Case 1. We first discuss the scenario when $\lambda_Q > 0$ (i.e., $\frac{Q}{m} = X_1^b$) and $\lambda_\delta = 0$ (i.e., $\delta_1^b < \delta^*$). In this case, the preexisting quota is effective and low enough to force the MPFs to abandon some relatively inefficient quota-bound products. From the first-order conditions for the scale of quota-bound and quota-free products, Eqs. (6) and (7), the profit margins of marginal varieties bound to quota and free of quota, $p_1(\delta_1^b) - w\gamma(\delta_1^b) - \lambda_Q$ and $p_1(\delta_1^f) - w\gamma(\delta_1^f)$, are both positive. Eqs. (10) and (11) imply that the export of marginal variety is zero, that is, $x_1(\delta_1^b) = 0$ and $x_1(\delta_1^f) = 0$. Combining these conditions with Eqs. (8) and (9), the first-order conditions with respect to the scope of quota-bound and quota-free products can be rewritten as:

$$w\gamma(\delta_1^b) = a' - \lambda_Q - b_1' e(Y_1 + X_1), \tag{14}$$

$$w\gamma(\delta_1^f) = a' - b_1' e(Y_1 + X_1). \tag{15}$$

Eqs. (14) and (15) give two relationships between export scope and scope, which are derived from the optimal scope strategies on quota-free and quota-bound products. Integrating Eqs. (8) and (9) for the firm's total export scale of quota-bound and quota-free products yields another two relationships:

$$X_1^b = \frac{Q}{m} = \int_0^{\delta_1^b} x_1(i)di = \frac{\left[a' - w\mu_\gamma(\delta_1^b) - \lambda_Q - b_1' e(Y_1 + X_1)\right] \delta_1^b}{2b_1'(1-e)}, \tag{16}$$

$$X_1^f = \int_{\delta^*}^{\delta_1^f} x_1(i)di = \frac{\left[a' - w\mu_\gamma(\delta^*, \delta_1^f) - b_1' e(Y_1 + X_1)\right] \left(\delta_1^f - \delta^*\right)}{2b_1'(1-e)}. \tag{17}$$

where $\mu_\gamma(a, b) \equiv \frac{1}{b-a} \int_a^b \gamma(i)di$ is the mean of the labor requirement distribution across all varieties in the range $[a, b]$, and $\mu_\gamma(0, b)$ can be simplified as $\mu_\gamma(b)$. Thus, $\mu_\gamma(\delta_1^b)$ denotes the average labor requirement for all quota-bound products exported by the firm to country 1, and $\mu_\gamma(\delta^*, \delta_1^f)$ denotes the average labor requirement for all quota-free products.

The symmetric equilibrium must be the solution when the equilibrium conditions for the scope and scale of quota-bound and quota-free products, Eqs. (14), (15), (16) and (17), are all satisfied. Differentiating the equilibrium conditions for scope and scale with respect to Q gives the effects of quota relaxation on scale and scope. Quota relaxation means export market-size expansion for quota-bound products and one-for-one increases in the total exports of these products ($\frac{d\ln X_1^b}{d\ln Q} = 1$). As for the individual export of each quota-bound variety, the direct market-size effect results in a uniform absolute increase in the export scale, which is given by differentiating $x_1(i)$ with respect to Q:

$$\frac{dx_1(i)}{d\ln Q} = \frac{Q}{m\delta_1^b} + \frac{w\left[\mu_\gamma(\delta_1^b) - \gamma(i)\right]}{2b_1'(1-e)}\frac{d\ln w}{d\ln Q},\ i \in \left[0, \delta_1^b\right]. \tag{18}$$

Detailed proofs of Eq. (18) and the following Eqs. (19)-(22) are given in Appendix 8.1. The first term on the right side represents the market-size expansion of quota-bound products. With given wage w ($d\ln w = 0$), the direct demand force of quota relaxation on $x_1(i)$ is $\frac{dx_1(i)}{d\ln Q} = \frac{Q}{m\delta_1^b}$, which is the same for any variety i. Ignoring the change in w leads to partial analysis focusing on the demand side. Intuitively, the direct demand force also leads to an increase in the export scope of quota-bound products:

$$\frac{d\ln\delta_1^b}{d\ln Q} = \left[\frac{2b_1'(1-e)}{w\delta_1^b\gamma_\delta(\delta_1^b)}\frac{Q}{m\delta_1^b}\right]\left(1 - \frac{d\ln w}{d\ln Q}\right), \tag{19}$$

where $\gamma_\delta(\cdot)$ is the derivative of labor requirement γ with respect to variety δ. Disregarding the changes in wage w, a positive market-size effect increases the scope of quota-bound products. After trade barrier reduction, less efficient quota-bound products that had been dropped from exports are now added to the export product line.

We then discuss the changes in the scale and scope of quota-free products. Taking Y_1 and w as given, the quota can only affect the export strategies of quota-free products through a cannibalization effect, which leads to a decrease in the scope of quota-free products:

$$\frac{d\ln\delta_1^f}{d\ln Q} = -\frac{2b_1'e(1-e)\frac{Q}{m} + \left\{2(1-e)\gamma(\delta_1^f) + e(\delta_1^f - \delta^*)\left[\gamma(\delta_1^f) - \mu_\gamma(\delta^*, \delta_1^f)\right]\right\}\frac{d\ln w}{d\ln Q}}{w\delta_1^f\gamma_\delta(\delta_1^f)\left[2(1-e) + e(\delta_1^f - \delta^*)\right]}. \tag{20}$$

The change in the total export scale of quota-free products X_1^f with respect to quota relaxation can be written as:

$$\frac{dX_1^f}{d\ln Q} = -\frac{\delta_1^f - \delta^*}{2b_1'(1-e) + b_1'e(\delta_1^f - \delta^*)}\left[\frac{b_1'eQ}{m} + w\mu_\gamma(\delta^*, \delta_1^f)\frac{d\ln w}{d\ln Q}\right]. \tag{21}$$

As Eq. (21) shows, the cannibalization effect leads to a decrease in the total exports of quota-free products to country 1. One percent increase in Q will lead to a $\frac{(\delta_1^f - \delta^*)eQ}{\left[2(1-e)+e(\delta_1^f-\delta^*)\right]m}$ unit decrease in X_1^f. Differentiating Eq. (9) and combining it with Eq. (21), we can get the change in the export scale of a given quota-free variety. The effect of quota relaxation on the export scale of quota-free variety i is given by:

$$\frac{dx_1(i)}{d\ln Q} = -\frac{eQ}{\left[2(1-e) + e(\delta_1^f - \delta^*)\right]m} - \frac{\left[\gamma(i) - \frac{e(\delta_1^f - \delta^*)}{2(1-e)+e(\delta_1^f-\delta^*)}\right]}{2b_1'(1-e)}w\frac{d\ln w}{d\ln Q}, i \in \left[\delta^*, \delta_1^f\right]. \tag{22}$$

The cannibalization effect leads to a uniform absolute fall in the export of each quota-free product. After relaxing the quota restriction, the direct market-size effect increases the export scale of quota-bound products X_1^b, and the cannibalization effect decreases the export scale of quota-free products X_1^f. Since $\frac{e(\delta_1^f-\delta^*)}{2(1-e)+e(\delta_1^f-\delta^*)} < 1$, we also demonstrate that the former dominates and the total export of MPFs to country 1, X_1, increases with quota relaxation.

Case 2. Next, we turn to the second case when $\lambda_Q > 0$ (i.e., $\frac{Q}{m} = X_1^b$) and $\lambda_\delta > 0$ (i.e., $\delta_1^b = \delta^*$). The quota restriction prevents MPFs from setting potential optimal exports of quota-bound products, but it is not sufficient enough to force MPFs to cut their product line. The scope of quota-bound products is equal to the exogenously determined δ^*. Eq. (10) and $\lambda_\delta > 0$ imply that $x_1(\delta_1^b) > 0$, which means the export of any quota-bound product to country 1 is positive. In this case, relaxing the quota will not affect the export scope of quota-bound products but will decrease the export scope of quota-free products through the cannibalization effect. Thus, the export scope of all products will decrease after quota relaxation. Apart from this, the other conclusions in the first case still hold.

Case 3. The last case, $\lambda_Q = 0$, indicates that the quota is too high to influence the export strategies of MPFs. The firm can still set the export scope and scale as optimal without considering the quota. This case is not the focus of this paper. The firm's optimal strategies on the scale and scope of exports to country 2 are much simpler and discussed in Appendix 8.2.

Figure 3 illustrates the demand force of quota relaxation in the partial analysis without considering the labor market. $x_1^*(i)$ denotes the potential optimal export of variety i to country 1 without quota constraints. The firm prefers to export more as the variety moves closer to its core competence. $x_1^{'}(i)$ denotes the individual product export with a quota equal to $Q^{'}$. The aggregate exports of

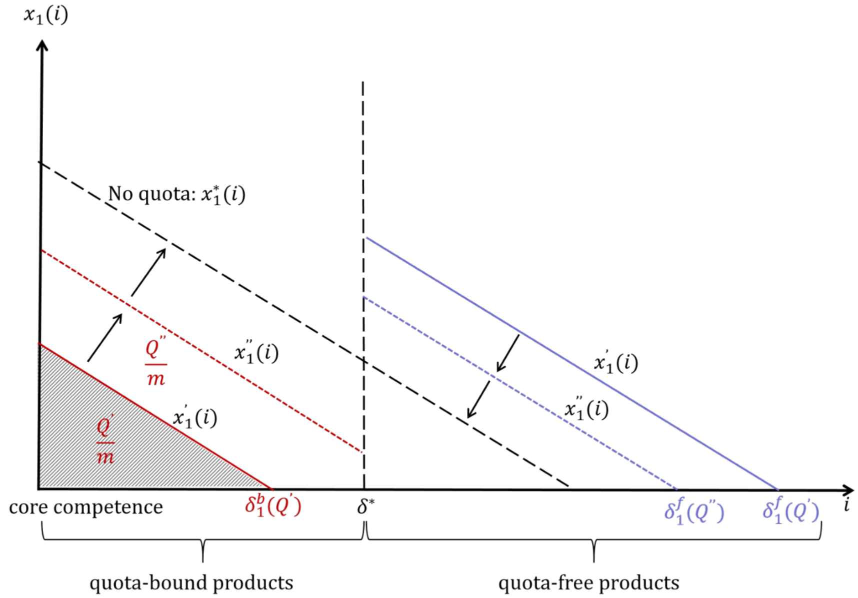

Figure 3: The demand effect of quota removal

Notes: Red (Blue) lines represent the individual export of quota-bound (quota-free) products to country 1. $x_1^*(i)$ denotes the potential optimal export of variety i to country 1 without quota constraints. $x_1^{'}(i)$ ($x_1^{''}(i)$) denotes the individual product export with a quota equal to $Q^{'}$ ($Q^{''}$). The arrows indicate quota relaxation with a given wage.

quota-bound products are capped at $Q^{'}$, which is represented by the area under the curve $x_1^{'}(i)$ on the left side of δ^*. Due to the export limit of quota-bound products, the firm will export more quota-free products compared to the no-quota situation. When relaxing the quota, $x_1(i)$ for quota-bound (quota-free) products shifts up (down) towards the curve without the quota, $x_1^*(i)$.

There are two important points in Figure 3. First, the direct market-size effect of quota relaxation leads to a uniform increase in the export of each quota-bound variety, and the cannibalization effect leads to a uniform decrease in the export of each quota-free variety. This jointly results in an export shift from quota-free towards quota-bound products. Second, the change in the scope of quota-bound products (δ_1^b) with respect to quota relaxation depends on the initial quota level. If the initial quota is very low (e.g., $Q^{'}$), quota relaxation will increase the export scope of quota-bound products, δ_1^b, but decreases the export scope of quota-free products, δ_1^f. The change in the export scope of all products is ambiguous. As given in Appendix 8.1, if $\frac{\gamma_\delta(\delta_1^b)}{\gamma_\delta(\delta_1^f)} > \frac{1}{\delta_1^b}\left[\frac{2(1-e)}{e} + \delta_1^f - \delta^*\right]$, the decrease in δ_1^f will dominate, and the export scope of all products will decrease as quota increases. However, if the initial quota is relatively high (e.g., $Q^{''}$), a further increase in the quota will not affect δ_1^b. In this case, the export scope of all products is completely determined by δ_1^f and decreases with quota relaxation.

3.5 Labor Market

Our previous discussion about the effects of quota relaxation focuses on the demand side, including the market-size effect for quota-bound products and the cannibalization effect for quota-free products. When no consideration is given to the labor market, we achieve partial equilibrium. To close our model, we then specify how the wage is endogenously determined and how the wage responds to quota changes.

We assume that all households in the origin country o supply one unit of labor inelastically, so the total labor supply equals the country's population L. The equilibrium wage should balance labor supply and labor demand. Let l_c denote the firm's labor requirements for producing the products exported to country c, which can be obtained by integrating $\gamma(i)x_c(i)$ across all exporting products. Thereafter, the total labor demand of m symmetric firms can be written as $m(l_1 + l_2 + f_1 + f_2)$. Labor is needed to produce products and cover the fixed cost of entering the destination market. In the first case of $\lambda_Q > 0$ and $\lambda_\delta = 0$, the labor-market equilibrium condition can be written as:

$$\frac{L}{m} = l_1 + l_2 + f_1 + f_2 = \int_0^{\delta_1^b} \gamma(i)x_1(i)di + \int_{\delta*}^{\delta_1^f} \gamma(i)x_1(i)di + \int_0^{\delta_2} \gamma(i)x_2(i)di + f_1 + f_2 \tag{23}$$

The first two integrations on the right side correspond to the labor requirements for producing products exported to country 1, l_1. The third integration equals l_2. We substitute the expressions for $x_c(i)$ into the integration in Eq. (23) to obtain:

$$\begin{aligned}\frac{L}{m} =& \frac{Q\mu_\gamma(\delta_1^b)}{m} - \frac{w\delta_1^b\sigma_\gamma(\delta_1^b) + \left[a' - b_1'e(X_1+Y_1)\right](\delta_1^f - \delta^*)\mu_\gamma(\delta^*, \delta_1^f) - w(\delta_1^f - \delta^*)\mu_\gamma''(\delta^*, \delta_1^f)}{2b_1'(1-e)} \\ &+ \frac{\left[a' - b_2'e(X_2+Y_2)\right]\delta_2\mu_\gamma(\delta_2) - w\delta_2\mu_\gamma''(\delta_2)}{2b_2'(1-e)},\end{aligned} \tag{24}$$

where $\mu_\gamma''(a,b) \equiv \frac{1}{b-a}\int_a^b \gamma^2(i)di$ is the second moment of the labor requirement distribution across all varieties in range $[a,b]$, and $\sigma_\gamma^2(a,b) \equiv \mu_\gamma''(a,b) - \mu_\gamma^2(a,b)$ is the variance of the firm's labor requirements across all its varieties in $[a,b]$. $\mu_\gamma''(0,b)$ and $\sigma_\gamma^2(0,b)$ can be simplified as $\mu_\gamma''(b)$ and $\sigma_\gamma^2(b)$, respectively.

Partially differentiating the variable labor requirements with respect to export scope δ_1^b gives $\frac{\partial l_1}{\partial \delta_1^b} = x_1(\delta_1^b)\gamma(\delta_1^b)$. As discussed above, the first-order condition for the export scope of quota-bound products indicates that the exports of the marginal quota-bound variety are zero, $x_1(\delta_1^b) = 0$. Thus, the partial derivative of variable labor requirements with respect to δ_1^b is also zero, $\frac{\partial l_1}{\partial \delta_1^b} = 0$, which similarly holds for scopes δ_1^f and δ_2. The above discussion implies that when the export scopes are optimally chosen, the expression of aggregate labor requirements is independent of δ_1^b,

δ_1^f, and δ_2. Hence, the envelope theorem allows us to differentiate Eq. (24) without considering δ_1^b, δ_1^f, and δ_2 explicitly to obtain the response of wage to quota change:

$$\frac{d\ln w}{d\ln Q} = \frac{\left[\mu_\gamma(\delta_1^b) - \frac{e(\delta_1^f-\delta^*)}{2(1-e)+e(\delta_1^f-\delta^*)}\mu_\gamma(\delta^*,\delta_1^f)\right]\frac{Q}{m}}{\frac{w\delta_1^b\sigma_\gamma^2(\delta_1^b)}{2b_1'(1-e)} + \frac{2(1-e)w(\delta_1^f-\delta^*)\mu_\gamma''(\delta^*,\delta_1^f)+ew(\delta_1^f-\delta^*)^2\sigma_\gamma^2(\delta^*,\delta_1^f)}{2b_1'(1-e)\left[2(1-e)+e(\delta_1^f-\delta^*)\right]} + \frac{2(1-e)w\delta_2\mu_\gamma''(\delta_2)+ew\delta_2^2\sigma_\gamma^2(\delta_2)}{2b_2'(1-e)[2(1-e)+e\delta_2]}}. \tag{25}$$

If the labor requirement increase induced by the direct market-size effect is larger than the labor requirement decrease induced by the cannibalization effect, i.e., $\mu_\gamma(\delta_1^b) > \frac{e(\delta_1^f-\delta^*)}{2(1-e)+e(\delta_1^f-\delta^*)}\mu_\gamma(\delta^*,\delta_1^f)$, quota relaxation will raise the equilibrium wage, which is referred to as the capacity constraint effect in this paper. In this setting, $\frac{d\ln w}{d\ln Q}$ inversely depends on the variances of labor requirements $\sigma_\gamma^2(\delta_1^b)$, $\sigma_\gamma^2(\delta^*,\delta_1^f)$, and $\sigma_\gamma^2(\delta_2)$. Lower variation in production technology across varieties is associated with a greater wage increase and a stronger capacity constraint effect. The intuition is clear: the more flexible the production techniques across different varieties, the easier it is for MPFs to reduce labor requirements by focusing on core varieties. The wage response to quota relaxation in the second case of $\lambda_Q > 0, \lambda_\delta > 0$ is similar to Eq. (25) with δ_1^b equal to δ^*.

The capacity constraint affects each variety's export quantity differently. As shown in Figure 3, demand forces shift the export scale of each quota-bound (quota-free) variety upwards (downwards) by the same absolute amount. However, Eq. (18) shows that an infinitesimal increase in wage leads to the export quantity curve of quota-bound products pivoting clockwise ($c_1 \rightarrow c_2$) around the threshold variety that has average labor requirements, $\mu_\gamma(\delta_1^b)$. As shown in Figure 4, for quota-bound varieties with $\gamma(i)$ smaller (larger) than $\mu_\gamma(\delta_1^b)$, the export increases (decreases) with equilibrium wage. Eq. (22) indicates that the capacity constraint effect also leads to non-uniform changes in the export quantity of quota-free varieties ($d_1 \rightarrow d_2$). The labor requirement of the threshold quota-free variety whose export is unaffected by wage increases is $\gamma^* = \frac{e(\delta_1^f-\delta^*)}{2(1-e)+e(\delta_1^f-\delta^*)}\mu_\gamma(\delta^*,\delta_1^f)$. Combined with the existence condition for capacity constraint effect, $\mu_\gamma(\delta_1^b) > \frac{e(\delta_1^f-\delta^*)}{2(1-e)+e(\delta_1^f-\delta^*)}\mu_\gamma(\delta^*,\delta_1^f)$, we can infer that $\gamma^* < \mu_\gamma(\delta_1^b)$, which means that the threshold variety does not fall into the quota-free product line and the export scale of any quota-free variety decreases. The reductions in individual exports of different quota-free products are uneven, with less of a reduction in relatively efficient varieties and more of a reduction in marginal varieties.

There is heterogeneity across products but no heterogeneity across destinations in the capacity constraint effect. Combining Eqs (8), (9), (18), and (22), we can conclude that the percentage export change of a given variety i arising from higher wages after quota removal is independent of the market size (i.e., population) of the destination country. Eqs (A15) and (A19) also indicate a constant percentage decrease in the export of variety i to the quota-free destination, where only the supply force is present, regardless of the destination's market size.

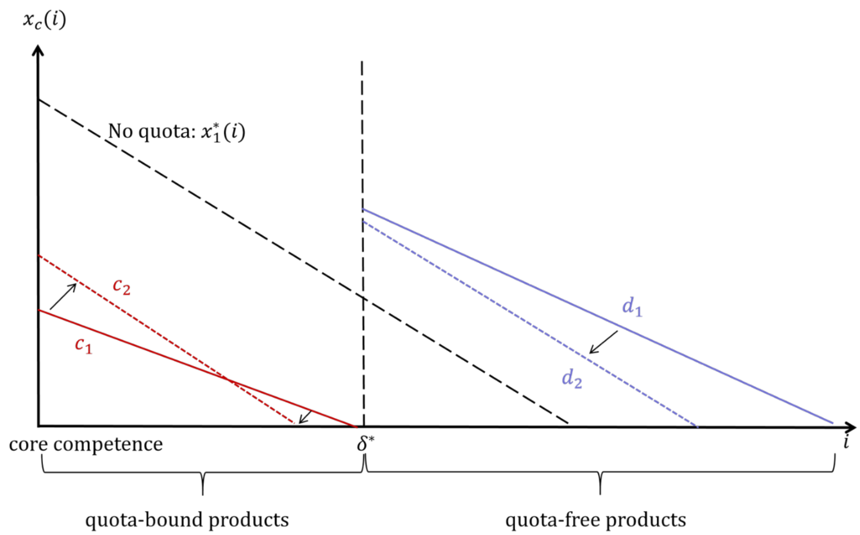

Figure 4: The capacity constraint effect of quota removal

Notes: Red (Blue) lines represent the individual export of quota-bound (quota-free) products to country 1. $x_1^*(i)$ denotes the potential optimal export of variety i to country 1 without quota constraints. The arrows indicate the capacity constraint effect of quota removal (i.e., wage increase) without considering demand forces.

The above analysis focuses on the removal of quotas imposed on core varieties. We also analyze how MPFs respond when removing the quota imposed on their marginal varieties in Appendix 8.3. The main theoretical findings still hold. Specifically, on the demand side, the market-size (cannibalization) effect increases (decreases) the individual export scale of each quota-bound (quota-free) variety by the same amount. The capacity constraint effect from the supply side affects each variety heterogeneously and forces MPFs to concentrate on their more efficient varieties. The main difference is the changes in the export scope of quota-bound and quota-free products to the quota-bound destination, which is summarized in Table 1. When removing the quota imposed on marginal varieties, there is no change in the export scope of quota-free products. However, the change in the export scope of quota-bound products is more complex and ambiguous, depending on the quota distribution along the product line and the initial level of the quota.[6]

3.6 Propositions

We now derive four propositions that can be empirically tested. As discussed in Table 1, the export scope of quota-bound products will decrease after quota removal if the quota is imposed on core

[6]For quota imposed on core varieties, removing it will increase the export scope of quota-bound products if the initial quota is low enough to force MPFs to abandon some quota-bound products. If the quota is relatively high, removing it will not change the export scope of quota-bound products. For quota imposed on marginal varieties, removing it may reduce the export scope of quota-bound products due to the steeper export quantity curve (see Appendix Figure A1).

varieties and will remain unchanged if the quota is imposed on marginal varieties. Given that both scenarios exist in the data (**Fact 3**), we expect to find a decrease in the export scope of quota-free products. However, the change in the export scope of quota-bound products is ambiguous.

Proposition 1: Product diversification

1a: *After quota removal, the export scope of quota-free products (δ_1^f) will decrease, whereas the change in the scope of quota-bound products is ambiguous. If the former dominates, the firm's export scope will decrease.*

Table 1: The effect of quota removal on export scope

	Export scope of quota-free products δ_1^f	Export scope of quota-bound products δ_1^b
Quota imposed on core varieties	$\downarrow$	Ambiguous ($\uparrow$ or $-$)
Quota imposed on marginal varieties	$-$	Ambiguous ($\uparrow$ or $\downarrow$)

As Eq. (21) shows, the reduction in product diversification is associated with export adjustments across products. The exports of quota-free products are negatively affected by both the demand-side cannibalization effect and the supply-side capacity constraint effect.

1b: *The cannibalization effect of quota removal decreases the exports of quota-free products, leading to an export shift towards quota-bound products.*

As discussed above, the capacity constraint effect forces MPFs to narrow their focus for both quota-bound and quota-free products, irrespective of the quota imposed on core or marginal varieties. We also show that demand forces of quota removal are only present in the quota-bound country, while the supply force can spill over to the quota-free country. From Eq. (A19), we can see that an increase in wage also causes the export quantity curve in country 2 to pivot clockwise around the threshold variety whose requirement equals $\frac{e\delta_2}{2(1-e)+e\delta_2}\mu_\gamma(\delta_2)$.

Proposition 2: *The capacity constraint effect of quota removal encourages MPFs to focus on their core competencies and give up their marginal varieties in both quota-bound and quota-free destinations.*

We now discuss destination diversification, which measures the number of countries to which each firm exports a given product. As shown in Eq. (A20), the effect of quota relaxation on MPFs' scope to the quota-free country is:

$$d\ln\delta_2 = -\frac{1}{\delta_2\gamma_\delta(\delta_2)}\left[\gamma(\delta_2) - \frac{e\delta_2}{2(1-e)+e\delta_2}\mu_\gamma(\delta_2)\right]\frac{d\ln w}{d\ln Q}. \tag{26}$$

Due to the capacity constraint effect, the scope of exports to country 2 decreases after quota relaxation. Higher wages force MPFs to give up exporting marginal varieties to the quota-free country. Conditional on **Proposition 1a**, quota relaxation negatively affects product scopes in both quota-bound and quota-free destination markets. In other words, MPFs must give up exporting some products, especially their marginal varieties, to some destinations.

Proposition 3: Destination diversification
3a: *Quota removal decreases MPFs' destination diversification, especially the destination diversification of their marginal varieties.*

We now turn to **Proposition 3b** and investigate changes in the export scale in the quota-free country. From Eqs. (A18) and (A20) in Appendix 8.2, the wage increase arising from quota relaxation negatively affects the firm's scale and scope of exports to country 2. Eq. (A10) in Appendix 8.1 shows that the effect of quota removal on the firm's total exports to country 1, X_1, can be decomposed as the demand force, which increases X_1 by $\frac{2(1-e)Q/m}{2(1-e)+e(\delta_1^f-\delta^*)}$, and the capacity constraint effect, which decreases X_1 by $\frac{w(\delta_1^f-\delta^*)\mu_\gamma(\delta^*,\delta_1^f)}{2b_1^{'}(1-e)+b_1^{'}e(\delta_1^f-\delta^*)}\frac{d\ln w}{d\ln Q}$. These two opposite effects on X_1 can partially offset each other. If $\frac{d\ln w}{d\ln Q} < \frac{2b_1^{'}(1-e)Q}{w(\delta_1^f-\delta^*)\mu_\gamma(\delta^*,\delta_1^f)m}$, the positive demand force dominates the negative capacity constraint effect so that X_1 increases after quota removal.

3b: *The capacity constraint effect of quota removal decreases the firm's exports to the quota-free country, shifting it to the quota-bound country.*

We have discussed how quota removal affects product and destination diversification so far, and then we derive the effect of quota removal on the export profits of MPFs. From Eqs. (A12) and (A22), the derivate of the firm's total export profits with respect to quota can be written as:

$$\begin{aligned}\frac{d\Pi}{d\ln Q} = &\left[\lambda_Q + \frac{2b_1^{'}e(1-e)X_1}{2(1-e)+e(\delta_1^f-\delta^*)}\right]\frac{Q}{m} - \left[\frac{e(\delta_1^f-\delta^*)\mu_\gamma(\delta^*,\delta_1^f)X_1}{2(1-e)+e(\delta_1^f-\delta^*)} + l_1\right]w\frac{d\ln w}{d\ln Q} \\ &- \left[\frac{e\delta_2\mu_\gamma(\delta_2)X_2}{2(1-e)+e\delta_2} + l_2\right]w\frac{d\ln w}{d\ln Q} - w(f_1+f_2)\frac{d\ln w}{d\ln Q}.\end{aligned} \tag{27}$$

Let $\Pi_1 \equiv \int_0^{\delta_1^b}[p_1(i) - w\gamma(i)]\,x_1(i)di + \int_{\delta^*}^{\delta_1^f}[p_1(i) - w\gamma(i)]\,x_1(i)di$ and $\Pi_2 \equiv \int_0^{\delta_2}[p_2(i) - w\gamma(i)]\,x_2(i)di$ denote the firm's operating profits from exporting to countries 1 and 2, respectively. The first and second terms on the right side of Eq. (27) capture the positive demand force and negative supply force of quota removal on Π_1, respectively. If the former dominates, quota removal will increase the operating profits from exporting to the quota-bound country. The third term measures the decrease in Π_2 due to higher equilibrium wages. We now briefly discuss how the total number of consumers in country 2, L_2, affect the response of Π_2 to quota removal. As demonstrated by Eckel and Neary (2010), the direct effect of an increase in L_2 is an equi-proportionate increase in the export scale of each variety $x_2(i)$ and the total export scale X_2, but no change in the export scope δ_2. An increase in L_2 directly leads to an equi-proportionate increase in $\frac{e\delta_2\mu_\gamma(\delta_2)X_2}{2(1-e)+\delta_2}$ and l_2. Therefore, we can believe that the higher the number of consumers in the quota-free country, the larger the decline in Π_2. The fourth term refers to increases in the fixed cost of entering destination markets.

Proposition 4: *Quota removal has an ambiguous effect on the total export profits, which is more likely to rise: (a) the stronger the positive demand force in quota-bound country relative to the negative constraint capacity effect; (b) the smaller the market size of the quota-free country (L_2); and (c) the lower the fixed cost for entering destination markets (f_1 and f_2).*

4 Data and Variable Construction

4.1 Data

We use two data sets in our empirical analysis: export data from China Customs and stock market data from the China Stock Market Accounting Research (CSMAR) database.

Export data

Our firm-level export transaction records for 2000–2007 are from China Customs. The data reports export value (in US dollars) and export quantity by exporter, 8-digit HS product, destination, and year. We use the detailed export data to calculate our measures of product and destination diversification as well as identify firms' exposure to quota removal.

Our data cleaning process is as follows. First, we limit our sample to firms exporting textile products, whose 2-digit HS categories fall between 50 and 63, and we only keep the top 50 destinations in the aggregate textile exports of the above firms during our sample period. Second, to avoid the interference of intermediary firms, we identify wholesalers and distributors as firms whose Chinese names have the English-equivalent meaning of "importer", "exporter", "trading", and "services" (Ahn et al. 2011). These firms are excluded from our analysis. Third, we rely on the above sample to compute three commonly used measures of diversification, whose constructions are detailed in Section 4.2. Fourth, we construct each firm's exposures to the quota removal policy by combining the firm's export records with the quota lists from the MFA. When analyzing product diversification, the firm's exposure is determined by the proportion of quota-bound products it exports to a specific destination before quota removal in 2005. When analyzing destination diversification, the firm's exposure is the proportion of quota-bound destinations in its exports of a given product before 2005.

Table 2: Summary Statistics

Panel A. Product mix, destination mix, and number of firms

	2000–2004		2005–2007	
	All	Quota-bound	All	Quota-bound
	(1)	(2)	(3)	(4)
Total number of export destinations	50	3	50	3
Total number of 8-digit HS products	7,339	515	7,697	542
Export share of quota-bound products		2.56%		4.47%
Total number of export firms	41,833	9,633	52,917	26,101

Panel B. Product mix and destination mix: firm-level evidence

	2000–2004	2005–2007
	(1)	(2)
Average number of quota-bound products	0.64	1.68
Average number of quota-bound destinations	0.99	1.42
Export share		
Quota-bound products (affected firms)	11.09%	17.99%
Quota-bound products (all firms)	3.01%	9.12%
Quota-bound destinations (affected firms)	40.60%	43.71%
Quota-bound destinations (all firms)	25.66%	33.91%

Notes. Data from China Customs between 2000 and 2007. Quota-bound destinations include the United States, the European Union, and Canada. Turkey is excluded as its lists of products subject to quotas are unavailable. The European Union is treated as a single entity since quotas are established for the union as a whole. Sample: firms with positive exports of textile and clothing products (2-digit HS: 50–63) and their export transactions of 8-digit HS products to the top 50 destinations. Quota-bound firms in Panel A are those who exported at least one quota-bound product in the period 2000–2004 or 2005–2007. Affected firms in Panel B are those that exported at least one quota-bound product before 2005 and were directly affected by quota removal.

The summary statistics of China's exports before and after the quota removal policy in 2005 are presented in Table 2. At the product level (Panel A), there is an increase in both the export value and the number of firms exporting quota-bound products. For example, out of 7,339 8-digit HS products exported between 2000 and 2004, only 515 were subject to quotas, accounting for 3% of China's aggregate export value. However, the share increased to 5% during 2005–2007. At the firm level (Panel B), we observe that after 2004, quota-bound products and destinations gained importance in the export baskets of export firms. The share of quota-bound products (destinations) in firms' exports increased from 11% (41%) to 18% (44%) in the affected firms that exported at least one quota-bound product before 2005. The above summary statistics give preliminary evidence suggesting export growth of quota-bound products and destinations after quota removal, and we will further explore and quantify the export adjustments across products and destinations in Section 5.

Stock market data

To assess the effect of quota removal on stock market performance, we obtain the daily stock returns from the CSMAR database. The data covers all listed firms in China and reports their basic information, financial statements, and stock market performances (e.g., daily stock price and returns). We focus on listed firms issuing A shares in mainland China and use their daily stock returns from January 1, 1994, to December 31, 1996, to analyze the stock market effect around the announcement date of April 15, 1994.[7] Any firm-daily observations with missing stock returns are dropped. When analyzing the stock market effect, export details are also needed to identify each firm's exposure to quota removal. Thus, we merge the stock market data with firm-level export data from China Customs through firms' names.[8]

4.2 Diversification Measures

We capture the product and destination diversification of MPFs via three measures. The first is the number of products and destinations, a commonly used measure of export diversification. However, this measure may overlook important information on the distribution of different products and destinations in China's exports. To deal with this limitation, we also adopt the Herfindahl index (HI) and entropy index (EI) (Hund et al. 2010).

[7]A shares, also known as domestic shares, are shares that are denominated in the Chinese Renminbi and traded in the Shanghai and Shenzhen stock exchanges, as well as the National Equities Exchange and Quotations.

[8]We combine exact matching and fuzzy matching to link firms between the two databases. First, we match customs and listed firms (including their subsidiaries) based on their full names for exact matching. Second, for the remaining unmatched firms, we simplify their names by removing "company", "limited", "shares", "group", "province", "factory", and "liability" and then perform fuzzy matching. Third, we keep all matching records with a match score larger than 0.8 and artificially check if each fuzzy match is correct through the basic information and shareholding structures of each pair of firms. The detailed matching results can be found in Appendix Table A2.

We utilize the firm-product-destination-year data to construct measures of product and destination export diversification. Specifically, we assess the diversification of export products through $\text{HI}_{cjt} = \sum_{h=1}^{n_{cjt}} S_{hcjt}^2$ and $\text{EI}_{cjt} = \sum_{h=1}^{n_{cjt}} S_{hcjt} \ln(1/S_{hcjt})$, where n_{cjt} represents the number of 8-digit HS products exported from firm j to destination c in year t, and S_{hcjt} denotes the share of product h in firm j's exports to destination c in year t. Analogously, the $\text{HI}_{hjt} = \sum_{c=1}^{n_{hjt}} S_{hcjt}^2$ and $\text{EI}_{hjt} = \sum_{c=1}^{n_{hjt}} S_{hcjt} \ln(1/S_{hcjt})$ can be used to measure the diversification of export destinations. Here, n_{hjt} represents the number of destinations to which firm j exports product h in year t, and S_{hcjt} represents the share of destination c in firm j's exports of product h. When the product or destination is unique, HIs are equal to one, and EIs are equal to zero. In contrast, when there are multiple products and destinations, HIs are less than one, and EIs are greater than zero. Lower HI and higher EI indicate a higher degree of diversification. Even if the number of export products or destinations is constant, different export distributions across products and destinations may still lead to variations in HIs and EIs (Jacquemin and Berry 1979).

5 Quota Removal and Export

This section empirically tests our theoretical propositions in Section 3. Specifically, we study MPFs' export decisions after quota removal by examining how exports shift from quota-bound products and destinations to quota-free ones within MPFs. We also identify the roles of demand and supply forces in intra-firm adjustments.

5.1 Product Specialization

We start our exploration by examining the impact of quota removal on product diversification. As demonstrated by **Proposition 1a**, the export scope of quota-free products will decrease after quota removal, while the change in each firm's overall export scope, a combination of the scope of quota-bound products and quota-free products, is ambiguous.

We define "product diversification" at the year-firm-destination level and quantify its changes in response to quota removal through the following two-way fixed effect regression specification:

$$DIV_{cjt} = \alpha_1 + \beta_1(QP_{cj} \times POST_t) + \phi_{ct} + \phi_{jt} + \phi_{cj} + \varepsilon_{cjt}, \tag{28}$$

where DIV_{cjt} represents the measures of product diversification defined in Section 4.2, including the number of 8-digit HS products exported by firm j to destination c in year t, HI_{cjt}, and EI_{cjt}. The key explanatory variable, $QP_{cj} \times POST_t$, is the interaction between policy exposure QP_{cj} and

Table 3: Quota removal and product diversification

	Quota-free products			All products		
	No. of quota-free products	HI^f_{cjt}	EI^f_{cjt}	No. of all products	HI_{cjt}	EI_{cjt}
	(1)	(2)	(3)	(4)	(5)	(6)
$QP_{cj} \times POST_t$	-0.53***	0.21***	-0.37***	-0.66***	0.18***	-0.44***
	(-23.63)	(39.26)	(-33.88)	(-30.64)	(35.89)	(-39.65)
Destination-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Destination-Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	969,315	953,146	953,146	978,547	978,547	978,547
R-squared	0.78	0.75	0.80	0.78	0.74	0.80

Notes. Regressions at the destination-firm-year level following Eq. (28). Sample: annual exports of 8-digit HS products from all firms in our sample to the top 50 destinations between 2000 and 2007. Columns (1)–(3) respectively report the effects of quota removal on firm j's number of quota-free products exported to destination c in year t (n^f_{cjt}), its Herfindahl index ($\text{HI}^f_{cjt} = \sum_{h=1}^{n^f_{cjt}} S^2_{hcjt}$) and entropy index across quota-free products ($\text{EI}^f_{cjt} = \sum_{h=1}^{n^f_{cjt}} S_{hcjt} \ln(1/S_{hcjt})$). Here, "$S_{hcjt}$" denotes the share of quota-free product h in firm j's total exports to destination c in year t. Columns (4)–(6) report similar regressions but include all products in our sample. The key explanatory variable is the interaction between policy exposure QP_{cj} and time indicator $POST_t$. QP_{cj} is the average share of quota-bound products in firm j's exports to destination c over 2000–2004 prior to quota removal. $POST_t$ equals one if year t is post-2004 and zero otherwise. Separate QP_{cj} and $POST_t$ are omitted due to collinearity. Columns (1) and (4) use Poisson regressions, and Columns (2), (3), (5), and (6) use linear regressions. Robust standard errors are reported in parenthesis. Significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

time indicator $POST_t = \mathbb{I}(t > 2004)$, which equals one if year t is post-2004 and zero otherwise. QP_{cj} is defined as the average share of quota-bound products in firm j's exports to destination c between 2000 and 2004. The regression utilizes the annual exports of 8-digit HS products from all firms in our sample to the top 50 destinations between 2000 and 2007.

The fixed effect structure in Eq. (28) comprises a full set of destination-year (ϕ_{ct}), firm-year (ϕ_{jt}) and destination-firm dummies (ϕ_{cj}). Firm-year and destination-year fixed effects control for time-invariant variations outside the firm in a flexible manner, e.g., firm characteristics, competition in destination markets, as well as other confounding macro- and micro-economic shocks during our sample period. They are critical for the parallel trends assumption. Destination-firm fixed effects are added to remove all time-invariant determinants of the outcome variables, e.g., idiosyncratic consumer tastes for each brand in different markets. With these fixed effects, we exploit the variations within a given firm-destination pair and identify the effect of quota removal on product diversification through coefficient β_1.

Table 3 presents the effect of quota removal on product diversification following Eq. (28). Columns (1)–(3) focus on the diversification of quota-free products and use the number of products, HI_{cjt}, and EI_{cjt} as the dependent variable, respectively. According to **Proposition 1a**, the export scope of quota-free products will definitively decrease due to cannibalization and capacity constraint effects. The statistically significant and negative coefficient of -0.53 in Column (1) and the evidence of higher export concentration across quota-free products in Columns (2) and (3) support the proposition. Columns (4)–(6) report similar regressions with all products in our sample. Column (4) shows that quota removal leads to a significant decrease of 11% (= 0.66/6.03) in the scope of all products, as the average number of firms' products before 2005 is 6.03. Given that the pre-2005 averages of HI_{cjt} and EI_{cjt} are 0.71 and 0.61, Columns (5) and (6) show that quota removal leads to a 25% (= 0.18/0.71) higher HI_{cjt} and a 72% (= 0.44/0.61) lower EI_{cjt}. The above results suggest that the decrease in the export scope of quota-free products drives a substantial decrease in product diversification after quota removal, even if the change in the scope of quota-bound products is theoretically ambiguous.

Motivated by **Proposition 1b**, we then quantify the intra-firm adjustments across products after quota removal, specifically the crowding out of quota-free products arising from the export expansion of quota-bound products, through the following regression specification at the product-destination-firm-year level:

$$Export_{hcjt} = \alpha_2 + \beta_2(QPC_{hc} \times POST_t) + \phi_{hcj} + \phi_{ht} + \phi_{ct} + \phi_{hjt} + \varepsilon_{hcjt}, \tag{29}$$

where the export outcome $Export_{hcjt}$ includes the (log) exports of product h from firm j to destination c in year t and its corresponding share in firm j's total exports to destination c. Exposure

Table 4: Quota removal and intra-firm adjustments across products

Panel A. Export adjustments between quota-bound and quota-free products in quota-bound destinations

	Log(export) (1)	Export share (%) (2)	Log(export) (3)	Export share (%) (4)
$QPC_{hc} \times POST_t$	0.15^{***}	2.98^{***}	0.21^{***}	3.03^{***}
	(3.68)	(6.21)	(3.39)	(4.22)
Product-Destination-Firm FE	Yes	Yes	Yes	Yes
Product-Year FE	Yes	Yes	Yes	Yes
Destination-Year FE	Yes	Yes	Yes	Yes
Product-Firm-Year FE	No	No	Yes	Yes
Observations	243,853	243,853	84,061	84,061
R-squared	0.71	0.81	0.87	0.93

Panel B. Heterogeneous responses across varieties

	Log(export) (1)	Export value (million USD) (2)	Export share (%) (3)
$QPC_{hc} \times POST_t$	0.06	-0.04^{*}	2.09^{***}
	(1.37)	(-1.68)	(4.36)
$QPC_{hc} \times POST_t \times Core_{hj}$	0.81^{***}	0.86^{***}	7.76^{***}
	(14.16)	(11.33)	(9.06)
Product-Destination-Firm FE	Yes	Yes	Yes
Product-Year FE	Yes	Yes	Yes
Destination-Year FE	Yes	Yes	Yes
Observations	243,853	243,853	243,853
R-squared	0.71	0.65	0.81

Notes. Regressions at product-destination-firm-year level following Eq. (29) (Panel A) and Eq. (31) (Panel B). Sample: annual exports of 8-digit HS products from Chinese firms with at least 80% of exports attributed to textile products to 3 quota-bound destinations (including the United States, the European Union, and Canada). In Panel A, the dependent variables include firm j's log exports of product h to destination c (Columns (1) and (3)) and its share in firm j's total exports to destination c (Columns (2) and (4)). The key explanatory variable is the interaction between QPC_{hc} and $POST_t$, where QPC_{hc} equals one if Chinese exports of product h to destination c were subject to quotas before 2005 and zero otherwise, and $POST_t$ equals one if year t is post-2004 and zero otherwise. Separate QPC_{hc} and $POST_t$ are omitted due to collinearity. In Panel B, the exports without log transformation are also added as the dependent variable in Column (2). The key explanatory variable is the triple interaction, where "$Core_{hj}$" is an indicator of core competence, equal to one if product h is the top product in firm j's exports in 2007 and zero otherwise. Separate QPC_{hc}, $POST_t$, and $Core_{hj}$ are omitted due to collinearity. Robust standard errors are reported in parenthesis. Significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

to quota removal, QPC_{hc}, is equal to one if product h is in the quota list of country c and zero otherwise.[9] Product-destination-firm fixed effects (ϕ_{hcj}) remove all time-invariant determinants of exports. Product-year (ϕ_{ht}) and destination-year fixed effects (ϕ_{ct}) control for linkages outside the firm and other confounding shocks (e.g., income changes and competition in destination markets). Importantly, we use product-firm-year fixed effects (ϕ_{hjt}) to account for the supply force and identify the role of demand forces.[10] We run the above regressions for firms with 80% or more of exports attributed to textile products, which we call textile firms, and utilize their annual exports of 8-digit HS products to quota-bound destinations between 2000 and 2007.[11]

Panel A of Table 4 reports the estimation results of Eq. (29), from which we can identify the intra-firm adjustments across products and isolate demand forces from the supply force. When controlling for product-year, destination-year, and destination-product-firm fixed effects in Columns (1) and (2), we find a 15% increase in exports of quota-bound products to quota-bound destinations after quota removal, and a 3% higher share of quota-bound products. These estimates are a combination of demand and supply forces. We then introduce product-firm-year fixed effects in Columns (3) and (4) to control for the supply force, and the estimates increase to 21% and 3%, indicating an export shift from quota-free to quota-bound products in quota-bound destinations through demand forces. When expanding the sample to all firms with positive textile exports, we also find a significant increase in the exports or export share of quota-bound products in Panel A of Appendix Table A3. These results support **Proposition 1b** and confirm the important role of the cannibalization effect in the export shift from quota-free to quota-bound products.

Panel A of Table 4 focuses on the intra-firm adjustments across products, and then we investigate the aggregate changes in the product mix of China to provide macro evidence. For an in-depth and systematic analysis, China's exports are divided into an intensive margin (including the export value and export share) and an extensive margin (export status).[12] We quantify their changes after quota removal through the following product-destination-year level specification:

$$Export_{hct} = \alpha_3 + \beta_3(QPC_{hc} \times POST_t) + \phi_{ht} + \phi_{hc} + \varepsilon_{hct}, \tag{30}$$

where $Export_{hct}$ is the export outcome, including the intensive and extensive margins of China's exports of product h to destination c in year t. Similar to Eq. (29), exposure QPC_{hc} is equal to

[9] We summarize the setups of treatment and control groups in different equations and tables in Appendix Table A1.

[10] We can do this because there is heterogeneity across products but no heterogeneity across destinations in the capacity constraint effect.

[11] We also expand the sample to all firms with positive exports of textile products and re-run the regressions in Eq. (29). The results are reported in Panel A of Appendix Table A3.

[12] Treating the number of firms per country as a continuous variable, the extensive margin can be divided into the intra-firm extensive margin (the number of varieties each firm exports) and the inter-firm extensive margin (the number of firms). Our extensive margin here is a combination of intra-firm and inter-firm extensive margins.

Table 5: Quota removal and China's export product mix

Panel A. Export value, quantity, and price for products in quota-bound destinations

	Log(export)		Log(quantity)		Log(price)	
	All firms	Textile firms	All firms	Textile firms	All firms	Textile firms
	(1)	(2)	(3)	(4)	(5)	(6)
$QPC_{hc} \times POST_t$	0.72^{***}	0.73^{***}	0.96^{***}	0.97^{***}	-0.24^{***}	-0.24^{***}
	(11.37)	(10.26)	(14.37)	(12.84)	(-10.28)	(-9.09)
Product-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Product-Destination FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs_product	7,707	4,053	7,707	4,053	7,707	4,053
Observations	78,135	21,970	78,135	21,970	78,135	21,970
R-squared	0.91	0.91	0.93	0.90	0.95	0.91

Panel B. Export share and export status for products in quota-bound destinations

	Export share (%)		Export status dummy	
	All firms	Textile firms	All firms	Textile firms
	(1)	(2)	(3)	(4)
$QPC_{hc} \times POST_t$	0.02^{***}	0.08^{***}	0.06^{***}	0.07^{***}
	(7.63)	(4.16)	(4.83)	(5.10)
Product-Year FE	Yes	Yes	Yes	Yes
Product-Destination FE	Yes	Yes	Yes	Yes
Obs_product	7,707	4,053	7,707	4,053
Observations	78,135	21,970	149,072	57,176
R-squared	0.94	0.87	0.82	0.79

Notes. Regressions at product-destination-year level following Eq. (30). Sample: aggregate exports of 8-digit HS products from all firms (odd columns) or textile firms (even columns) to 3 quota-bound destinations (including the United States, the European Union, and Canada), where textile firms are those with 80% or more textile-related exports. In Panel A, the dependent variables include the log export value (Columns (1)–(2)), quantity (Columns (3)–(4)), and price (Columns (5)–(6)). In Panel B, the dependent variables include the share of product h in exports to destination c (Columns (1)–(2)) and an export status dummy (Columns (3)–(4)), which equals one if China exports product h to destination c in year t and zero otherwise. The key explanatory variable is the interaction between QPC_{hc} and $POST_t$, where QPC_{hc} equals one if Chinese exports of product h to destination c were subject to quotas before 2005 and zero otherwise, and $POST_t$ equals one if year t is post-2004 and zero otherwise. Separate QPC_{hc} and $POST_t$ are omitted due to collinearity. Robust standard errors are reported in parenthesis. Significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

one if product h is in the quota list of country c and zero otherwise, and $POST_t$ indicates whether year t is post-2004 or not. We include product-year fixed effects (ϕ_{ht}) to control for time-variant product characteristics and product-destination fixed effects (ϕ_{hc}) to control for all time-invariant heterogeneity. We run the above regressions with annual aggregate exports across all firms in our sample or only textile firms to quota-bound destinations between 2000 and 2007, respectively.

Table 5 presents the effects of quota removal on the intensive and extensive margins of China's exports following Eq. (30). There are three main findings. First, quota removal makes quota-bound products more dominant in China's export portfolio, which is reflected by higher export value, share, and possibility of quota-bound products. Second, the reduction in product scope is associated with an export shift from quota-free to quota-bound products. Specifically, there is a statistically significant increase in the share of quota-bound products in China's exports to a specific quota-bound destination of 0.02% for all firms and 0.08% for textile firms. Third, since textile firms export more relevant quota-bound products than other wide-range firms, the impacts are more pronounced when only textile firms are considered.

Proposition 2 highlights the heterogeneity in export responses across products, which we empirically explore next. The capacity constraint effect influences each variety's export differently and encourages MPFs to focus on their core competencies. In other words, among the quota-bound products experiencing export expansion, the increase in the export of core competence should be the largest. With this guidance, we identify each firm's core competence "$Core_{hj}$" based on the share of each product h in firm j's exports in 2007, the third year after quota removal.[13] Specifically, $Core_{hj}$ equals one if the share of product h in firm j's exports is the largest among all export products of firm j and zero otherwise.[14] To identify the different changes in exports of core and non-core varieties, we interact $Core_{hj}$ with the key variable in Eq. (29) and obtain the following regression specification with a triple interaction:

$$Export_{hcjt} = \alpha_4 + \beta_4(QPC_{hc} \times POST_t) + \xi(QPC_{hc} \times POST_t \times Core_{hj}) + \theta Core_{hj} + \phi_{hcj} + \phi_{ht} + \phi_{ct} + \varepsilon_{hcjt}, \quad (31)$$

where $Export_{hcjt}$ is the export outcome, including the exports of product h from firm j to destination c in year t and its corresponding share in firm j's total exports to destination c. With product-destination-firm (ϕ_{hcj}), product-year (ϕ_{ht}), and destination-year fixed effects (ϕ_{ct}), the coefficient β_4 captures the demand forces and the average supply force across all quota-bound products. In the presence of heterogeneous export changes across products, the coefficient ξ is

[13] As shown in Figures 3 and 4, there is a downward-sloping export curve starting from the core competence with the highest exports when there is no quota constraint. However, the quota imposed on some products can disturb the monotonic relationship between the efficiency of products and their exports. Therefore, we identify the firm's core competence based on its exports after quota removal, not before.

[14] We also consider an alternative and broader definition of core competence for robustness in Appendix Table A4, where a product is defined as "$Core_{hj}$" if its share in firm j's exports falls into the top two or three among all products exported by firm j in 2007.

expected to be statistically significant and positive. The regression utilizes the annual exports of 8-digit HS products from textile firms to quota-bound destinations between 2000 and 2007.[15]

Panel B of Table 4 reports the product-heterogeneous export responses estimated with Eq. (31). In Column (1), we use log exports as the dependent variable and find a positive and statistically significant relative increase of 81% in exports of core varieties compared to non-core ones. Note that demand forces of quota removal increase (decrease) the exports of all quota-bound (quota-free) products by the same amount rather than the same percentage, as shown by Eqs. (18) and (22) in our theoretical framework. To ensure that $QPC_{hc} \times POST_t$ is able to control for demand forces completely, we also use exports (in million USD) without log transformation as the dependent variable in Column (2) and estimate a positive coefficient ξ of 0.86. Column (3) also reports a positive ξ of 7.76 with the export share in percentage as the dependent variable. The above findings are consistent with **Proposition 2** and provide supportive evidence for the presence of the supply force.

To sum up, our findings indicate that quota removal leads to product specialization and a skewed product mix toward quota-bound products. The capacity constraint effect introduces product-heterogeneous adjustments within firms and the export expansion of quota-bound products is dominated by MPFs' core competencies.

5.2 Destination Specialization

We have discussed the intra-firm adjustments across products in quota-bound destination markets in Section 5.1. We now turn to firms' export reallocation across destinations after quota removal. Although segmented destination markets imply independent demand forces, wage increases from the supply side increase the marginal costs of all products exported to all destinations. In other words, removing the quota imposed by one country can influence MPFs' export decisions to other countries through the capacity constraint effect.

Motivated by **Proposition 3a**, we investigate how quota removal affects MPFs' destination diversification strategies. Analogous to product diversification at the destination-firm-year level, "destination diversification" is defined at the product-firm-year level. We use the following regression to quantify its changes in response to quota removal:

$$DIV_{hjt} = \alpha_5 + \beta_5(QC_{hj} \times POST_t) + \phi_{ht} + \phi_{jt} + \phi_{hj} + \varepsilon_{hjt}, \tag{32}$$

where DIV_{hjt} represents the measures of destination diversification, including the number of desti-

[15] We also expand the sample to all firms with positive exports of textile products and re-run the regression in Eq. (31). The results are reported in Panel B of Appendix Table A3.

Table 6: Quota removal and destination diversification

	No. of destinations (1)	HI_{hjt} (2)	EI_{hjt} (3)	No. of destinations (4)	HI_{hjt} (5)	EI_{hjt} (6)
$QC_{hj} \times POST_t$	-0.16***	0.02***	-0.04***	-0.18***	0.03***	-0.05***
	(-32.09)	(11.29)	(-9.99)	(-35.38)	(12.69)	(-12.20)
$QC_{hj} \times POST_t \times Core_{hj}$				0.20***	-0.05***	0.13***
				(23.16)	(-11.85)	(16.58)
Product-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Product-Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,776,794	2,776,794	2,776,794	2,776,794	2,776,794	2,776,794
R-squared	0.34	0.70	0.74	0.34	0.70	0.74

Notes. Regressions at the product-firm-year level following Eq. (32). Sample: annual exports of 8-digit HS products from Chinese firms with positive textile and clothing exports to the top 50 destinations between 2000 and 2007. Columns (1)–(3) respectively report the effects of quota removal on the number of destinations for firm j's exports of product h, the corresponding Herfindahl index ($\text{HI}_{hjt} = \sum_{c=1}^{n_2} S_{hcjt}^2$), and entropy index ($\text{EI}_{hjt} = \sum_{c=1}^{n_2} S_{hcjt} \ln(1/S_{hcjt})$), where "$S_{hcjt}$" is the share of destination c in firm j's exports of product h in year t. In Columns (1)–(3), the key explanatory variable is the interaction between a policy exposure QC_{hj} and a time indicator $POST_t$. QC_{hj} is the average share of quota-bound destinations in firm j's exports of product h over 2000–2004 prior to quota removal. $POST_t$ equals one if year t is post-2004 and zero otherwise. Separate QC_{hj} and $POST_t$ are omitted due to collinearity. Columns (4)–(6) introduce the triple interaction, where $Core_{hj}$ equals one if product h is the top one in firm j's exports in 2007 and zero otherwise. Separate QC_{hj}, $POST_t$, and $Core_{hj}$ are omitted due to collinearity. Columns (1) and (4) use Poisson regressions, and Columns (2), (3), (5), and (6) use linear regressions. Robust standard errors are reported in parenthesis. Significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

nations to which firm j exports product h in year t, HI_{hjt}, and EI_{hjt}, which are defined in Section 4.2. The policy exposure QC_{hj} is the average share of quota-bound destinations in firm j's exports of a given product h between 2000 and 2004. A higher QC_{hj} indicates greater sensitivity to quota removal. We include product-year (ϕ_{ht}), firm-year (ϕ_{jt}), and product-firm fixed effects (ϕ_{hj}). The regression utilizes annual exports of 8-digit HS products from all firms in our sample to the top 50 destinations between 2000 and 2007, including exports to both quota-bound and quota-free countries.

Columns (1)–(3) of Table 6 present the effect of quota removal on destination diversification estimated by Eq. (32). Consistent with **Proposition 3a**, we observe a 9% (= 0.16/1.76) decrease in the number of firms' export destinations, a 2% (= 0.02/0.90) increase in HI_{hjt}, and a 21% (= 0.04/0.19) decrease in EI_{hjt}. These findings indicate destination shrinkage after quota removal due to the capacity constraint effect, i.e., export expansion in quota-bound destinations increases wages and decreases firms' profit margins of their products in quota-free destinations.

Another important prediction in **Proposition 3a** is that the destination shrinkage is heterogeneous across different varieties. As marginal varieties experience the largest export reduction caused by the capacity constraint effect while the export of core competencies decreases less or even increases, the destination shrinkage should be driven by marginal varieties. To test this, we interact $Core_{hj}$ with the key variable in Eq. (32) and report the corresponding regression results in Columns (4)–(6) of Table 6. We observe a statistically significant and larger reduction in the destination number for firms' non-core varieties in Column (4), supported by the coefficient of $QC_{hj} \times POST_t$. Correspondingly, we can conclude that there is a relative increase in the destination number of core varieties compared to non-core ones from the significantly positive coefficient of $QC_{hj} \times POST_t \times Core_{hj}$. Columns (5) and (6) use HI_{hjt} and EI_{hjt} as the measure of destination diversification and also support the above findings.

Having found that firms funnel their exports to fewer destinations after quota removal, we then discuss what destinations to concentrate on. **Proposition 3b** theoretically predicts that firms skew their exports from quota-free destinations toward quota-bound ones. To test this, we rely on export value, quantity, price, and the share of quota-bound destinations in China's exports to provide evidence on the intensive margin and export status in order to analyze the adjustments of the extensive margin. Our regression specification is as follows:

$$Export_{ct} = \alpha_6 + \beta_6(Q_c \times POST_t) + \phi_c + \phi_t + \varepsilon_{ct}, \tag{33}$$

where $Export_{ct}$ represents China's export outcome for destination c in year t. Q_c is an indicator variable equal to one for quota-bound destinations and zero otherwise. Destination (ϕ_c) and year fixed effects (ϕ_t) are included. We run the regression with the whole sample and a sub-sample that

Table 7: Quota removal and China's export destination mix

Panel A. Export value, quantity, and price

	Log(export)		Log(quantity)		Log(price)	
	All products	Textiles	All products	Textiles	All products	Textiles
	(1)	(2)	(3)	(4)	(5)	(6)
$Q_c \times POST_t$	-0.14	0.39^{***}	-0.06	0.57^{***}	-0.08	-0.18^{*}
	(-1.25)	(4.21)	(-0.51)	(3.74)	(-0.69)	(-1.84)
Destination FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	394	392	394	392	394	392
R-squared	0.92	0.93	0.87	0.90	0.73	0.74

Panel B. Export share and export status

	No. of products		Export share (%)		Export status dummy	
	All products	Textiles	All products	Textiles	All products	Textiles
	(1)	(2)	(3)	(4)	(5)	(6)
$Q_c \times POST_t$	-0.09^{***}	-0.08^{***}	1.61^{***}	1.43^{***}	-0.003	-0.007
	(-2.91)	(-2.98)	(4.07)	(4.43)	(-0.33)	(-0.92)
Destination FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	394	392	394	392	394	392
R-squared	0.93	0.87	0.86	0.91	0.75	0.88

Notes. Regressions at destination-year level following Eq. (33). Sample: annual aggregate exports of all products in our sample (odd columns) or textile products (even columns) to the top 50 destinations between 2000 and 2007. In Panel A, the dependent variables include the log export value (Columns (1)–(2)), quantity (Columns (3)–(4)), and price (Columns (5)–(6)). In Panel B, the dependent variables include the share of destination c in China's exports (Columns (1)–(2)) and an export status dummy (Columns (3)–(4)), which equals one if China exports to destination c in year t and zero otherwise. The key explanatory variable is the interaction between Q_c and $POST_t$, where Q_c equals one if China's textile exports to destination c were subject to quotas before 2005 and zero otherwise, and $POST_t$ equals one if year t is post-2004 and zero otherwise. Separate Q_c and $POST_t$ are omitted due to collinearity. Robust standard errors are reported in parenthesis. Significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

only includes textile products between 2000 and 2007, respectively. We would expect a stronger effect in the latter sample as textile products are more affected by quota removal.

Table 7 reports the regression results of Eq. (33) and shows that quota removal shifts MPFs' exports from quota-free destinations to quota-bound destinations. Specifically, when only focusing on textile products, quota removal leads to an average 1% increase in the share of quota-bound destinations in China's exports (Column (4) of Panel B). With log exports as the dependent variable, the differences in significance and magnitude of coefficients in Columns (1) and (2) of Panel A indicate that products with greater relevance to the policy, such as textiles, are more likely to experience export reallocation across destinations. Additionally, the decline in the number of products in Columns (1) and (2) of Panel B provides similar evidence of product specialization, which has been previously discussed in Section 5.1.

5.3 Spillovers to Non-OECD Countries

Having discussed the export adjustments across products and destinations, we conduct further analysis of the spillover effect of quota removal in this section. Specifically, we will show that removing the quota imposed on textile products from China to the United States, the European Union, and Canada can negatively influence China's exports of non-textile products to non-OECD countries, providing further powerful evidence for the presence of supply forces.

We explore how quota removal affects the intensive and extensive margins of non-textile exports to non-OECD countries through the following specification:

$$Export_{jt} = \alpha_7 + \beta_7(Q_j \times POST_t) + \phi_j + \phi_t + \varepsilon_{jt}. \quad (34)$$

When discussing the extensive margin, $Export_{jt}$ refers to the number of non-textile products, the number of non-OECD destination countries, and an export status dummy that equals one if firm j exports non-textile products to non-OECD countries in year t and zero otherwise. When discussing the intensive margin, $Export_{jt}$ refers to the export value, quantity, and price of non-textile products exported to non-OECD countries as well as the share of non-textile products exported to non-OECD countries in the firm's exports. Policy exposure Q_j is the share of quota-bound products exported to quota-bound countries in firm j's total exports over 2000–2004. Firm fixed effects (ϕ_j) control for time-invariant determinants of export outcomes, and year-fixed effects (ϕ_t) control for shocks common to all firms. We run the above regressions with the export transactions of all firms in our sample from 2000 to 2007.

Table 8 reports the regression results of Eq. (34), indicating that high-exposure firms tend to give up their exports of non-textile products to non-OECD countries, both in terms of intensive

Table 8: Spillovers to non-textile exports to non-OECD countries

Panel A. Export value and quantity of non-textile products to non-OECD countries

	Asinh(export) (1)	Asinh(quantity) (2)	Log(price) (3)
$Q_j \times POST_t$	-4.13***	-3.84***	-0.09
	(-27.07)	(-27.39)	(-0.56)
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	519,000	519,000	88,452
Obs_Firm	64,875	64,875	64,875
R-squared	0.57	0.56	0.78

Panel B. Export share and status of non-textile products to non-OECD countries

	No. of non-textile products (1)	No. of non-OECD countries (2)	Export share (%) (3)	Export status dummy (4)
$Q_j \times POST_t$	-4.87***	-2.74***	-11.27***	-0.32***
	(-11.55)	(-17.88)	(-25.70)	(-22.86)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	256,456	256,456	519,000	519,000
Obs_Firm	64,875	64,875	64,875	64,875
R-squared	0.63	0.48	0.48	0.52

Notes. Regressions at firm-year level following Eq. (34). Sample: annual exports of 8-digit HS products from firms in our sample between 2000 and 2007. In Panel A, the dependent variables in Columns (1)–(3) are the inverse hyperbolic sine (arcsin) export value, quantity, and log price of non-textile products from firm j to non-OECD countries in year t. In Panel B, the dependent variables in Columns (1)–(4) are firm j's number of non-textile products, the number of non-OECD countries, the share of non-textile products to non-OECD countries in firm j's total exports in year t, and an export status dummy, which equals one if firm j exports non-textile products to non-OECD countries in year t and zero otherwise. The key explanatory variable is the interaction between Q_j and $POST_t$. Q_j is the average share of quota-bound products exported to quota-bound destinations in firm j's total exports over 2000–2004. $POST_t$ is an indicator that equals one if year t is post-2004 and zero otherwise. Separate Q_j and $POST_t$ are omitted due to collinearity. Robust standard errors are reported in parenthesis. Significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 9: Quota removal and scope of quota-bound products

	No. of products (1)	HI^b_{cjt} (2)	EI^b_{cjt} (3)	No. of products (4)
$QP_{cj} \times POST_t$	-1.36***	0.002	-0.30***	-1.75***
	(-20.58)	(0.07)	(-5.19)	(-12.52)
$QP_{cj} \times POST_t \times SQ_j$				0.48***
				(3.04)
Destination-Year FE	Yes	Yes	Yes	Yes
Firm-Year FE	Yes	Yes	Yes	Yes
Destination-Firm FE	Yes	Yes	Yes	Yes
Observations	52,573	31,878	31,878	52,573
R-squared	0.66	0.85	0.84	0.66

Notes. Regressions at destination-firm-year level following Eq. (28). Sample: annual exports of 8-digit HS quota-bound products from all firms in our sample to the top 50 destinations between 2000 and 2007. In Columns (1)–(3), the dependent variables are the number of quota-bound products exported from firm j to destination c in year t (n^b_{cjt}), the Herfindahl index ($\text{HI}^b_{cjt} = \sum_{h=1}^{n^b_{cjt}} S^2_{hcjt}$) and the entropy index across quota-bound products ($\text{EI}^b_{cjt} = \sum_{h=1}^{n^b_{cjt}} S_{hcjt} \ln(1/S_{hcjt})$). Here, "$S_{hcjt}$" denotes the share of quota-bound product h in firm j's total exports to destination c in year t. The key explanatory variable is the interaction between policy exposure QP_{cj} and time indicator $POST_t$. QP_{cj} is the average share of quota-bound products in firm j's exports to destination c over 2000–2004 prior to quota removal. $POST_t$ equals one if year t is post-2004 and zero otherwise. Separate QP_{cj} and $POST_t$ are omitted due to collinearity. Column (4) reports the number of quota-bound products regressed on a triple interaction, where SQ_j measures the distribution of quotas along firm j's product line. SQ_j equals 1 if firm j's core varieties are more subject to quotas compared to its marginal varieties and zero otherwise. Core and marginal varieties are identified with firm j's exports in 2007. Columns (1) and (4) use Poisson regressions, while Columns (2) and (3) use linear regressions. Robust standard errors are reported in parenthesis. Significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

and extensive margins. Columns (1)–(3) of Panel A suggest that MPFs' non-textile exports to non-OECD countries decrease significantly after quota removal, and the subsequent reduction in export value is driven by lower export quantity rather than price. Columns (1) and (2) of Panel B indicate that quota removal encourages MPFs to reduce the number of non-textile products and non-OECD destination countries. Column (3) shows an 11% decrease in the share of non-textile products exported to non-OECD countries in the firms' total exports. Column (4) indicates that firms whose exports were previously focused on quota-bound products and destinations are more likely to exit other markets after quota removal.

5.4 Heterogenous Responses of Quota-bound Products

Our theoretical framework shows that the change in MPFs' export scope of quota-bound products after quota removal depends on whether the quota-bound products are the firms' core varieties.

When a firm's core varieties are subject to quotas, the export scope of quota-bound products will increase or remain unchanged after quota removal. When a firm's marginal varieties are subject to quotas, the export scope of quota-bound products is likely to decrease after quota removal. As shown in **Fact 3** in Section 2.2, 45% of exporters' core varieties are subject to quotas. In this section, we quantify the different responses of quota-bound products to quota removal in the above two scenarios.

First, to empirically test the overall response of quota-bound products to quota removal, we run the regression in Eq. (28) with the number of quota-bound products as the dependent variable. Column (1) of Table 9 shows that quota removal leads to a significant reduction in the number of quota-bound products. Columns (2) and (3) also exhibit a reduction in the diversification of quota-bound products. According to our framework, the findings are mainly driven by firms whose marginal varieties are subject to quotas.

To further test the above prediction, we construct SQ_j to quantitatively measure the quota distribution along a firm's product line. First, we use Q_{hj} to identify whether product h of firm j is in the quota lists, taking one if so and zero if not. We then average Q_{hj} across products, where the weight is the share of product h in firm j's total exports s_{hj}. Among the 6,640 products exported by affected firms, 447, or 7%, were subject to quotas before 2005. The weighted average term $\sum_h s_{hj}Q_{hj}$ is equal to 7% if the quota-bound products are randomly drawn from all products.[16] Thus, we define SQ_j as $SQ_j = \mathbb{I}(\sum_h s_{hj}Q_{hj} > 7\%)$. SQ_j equals one if firm j's core varieties are more likely to be subjected to quotas compared to its marginal varieties and zero otherwise. Column (4) of Table 9 reports the scope of quota-bound products regressed on the interaction between SQ_j and the key explanatory variable $QP_{cj} \times POST_t$. For firms with marginal varieties more subject to quotas, quota removal leads to a 2% decrease in their scope of quota-bound products. As a comparison, there is a 0.5% relative increase for firms whose core varieties are more subject to quotas. The above findings support our theoretical predictions.

5.5 Pre-trends and Placebo

In this section, we address the concerns on endogeneity by testing pre-trends and conducting a placebo test. First, we test the parallel trend assumption through a dynamic DID specification. Taking the regression of product diversification in Eq. (28) as an example, its dynamic specification

[16] Random choices of quota-bound products disregarding their export performance implies that the probability of each product being subject to the quota is 7%.

is given as follows:

$$DIV_{cjt} = \alpha_1 + \sum_{l=-3, l\neq 0}^{l=2} \beta_l (QP_{cj} \times D_t^l) + \phi_{ct} + \phi_{jt} + \phi_{cj} + \varepsilon_{cjt}, \tag{35}$$

where $D_t^l = \mathbb{I}(t - 2005 = l)$ is an indicator being l years away from quota removal in 2005. The year of quota removal ($t = 2005$ and $l = 0$) is excluded as a base group. Distant relative years before quota removal ($l < -3$) are binned into the $l = -3$ group. When using the number of products, HI_{cjt}, and EI_{cjt} as the dependent variable, the dynamic coefficients β_l are shown in Panel A of Appendix Figure A2. As for destination diversification, its dynamic coefficients estimated with similar specifications are reported in Panel B of Appendix Figure A2. All of the pre-trend coefficients in both figures are statistically insignificant or have opposite signs with the post-2004 coefficients. This implies that there are no observable export specialization trends of high-exposure firms compared to low-exposure firms before quota removal. After quota removal, there is an immediate and substantial reduction in the export diversification of products and destinations. These findings support of our theoretical predictions.

Second, we conduct a placebo test by setting the year 2002 as a fake treatment time. Specifically, we keep years before 2004 and then re-run the baseline regressions in Eqs. (28) and (32) to examine the relative export changes of high-exposure firms compared to low-exposure ones before and after the fake treatment time. The results are reported in Appendix Table A5. The estimated effects on product diversification (Panel A) and destination diversification (Panel B) are statistically insignificant or have opposite signs with the baseline results in Tables 3 and 6, suggesting that the export specialization after quota removal does not reflect pre-trends.

5.6 Alternative Story: Misallocation

We address the concern that specialization may arise from eliminating the misallocation of quota licenses rather than removing the quota itself. Khandelwal et al. (2013) find that China's quotas of textiles and clothing were managed by inefficient institutions. Specifically, "excessive" quotas were allocated to state-owned enterprises (SOEs) before 2004. After quota removal in 2005, more productive private firms entered and gained a market share at the expense of SOEs.

Quota misallocation introduces two plausible alternative mechanisms that can explain our main findings. First, private firms typically have a narrower scope of product varieties and fewer destination markets than SOEs, so their entry itself lowers the average level of diversification. To alleviate this concern, we restrict the sample to SOEs and replicate the baseline regressions in Eqs. (28) and (32). The results are reported in Columns (1) and (4) of Table 10, which still exhibit a significant reduction in product and destination diversification after quota removal.[17] Thus, the specialization in our main results is not driven by the entry of private firms after quota removal.

Second, more productive entrants increase competition between firms, and tougher competition can also force MPFs to concentrate more on their core varieties (Mayer et al. 2014). As suggested by Khandelwal et al. (2013), the largest exporters affected by quotas were most vulnerable to the competition of entrants and experienced the largest decline in market share after quota removal. Thus, we assess firms' sensitivity to tougher competition through the changes in their market shares and split the incumbents into two groups, those who managed to maintain their market shares versus those who did not.[18][19] The first group is less affected by tougher competition. Using this sub-sample for regression, we still find a significant reduction in product and destination diversification of 44% and 4% in Columns (2) and (5) of Table 10. In Columns (3) and (6), the estimates are 43% and 4% for firms more susceptible to tougher competition. The coefficient estimate in Column (2) (Column (5)) is statistically indistinguishable from that in Column (3) (Column (6)), with a p-value of 0.19 (0.47). Thus, inter-firm competition has a limited influence on our main results.

6 Stock Market Performance

In this section, we turn to the effect of quota removal on the stock performance of Chinese listed firms. As discussed in **Proposition 4**, the effect of quota removal on the profits of MPFs is ambiguous, depending on whether the positive demand force or negative supply force dominates. To answer this question empirically, we specify the impact of quota removal on MPFs' expected profits according to stock market performance. As a complement to previous studies on how trade liberalization affects stock returns (Breinlich 2014; Greenland et al. 2020; Benguria et al. 2022; Dür and Lechner 2023; Han et al. 2023; Li et al. 2023), we find that quota removal has a positive effect on MPFs' expected profits in the future.

We apply an event study with the insight that stock price movements on the announcement date are principally driven by the news of quota removal. The removal of quotas was announced on April 15, 1995, at the end of the Uruguay Round. The Marrakesh Declaration, signed on the same day, determined the implementation date and the list of products that would be removed from quotas in the following four phases.

[17] We use EI here because it changes in the same direction as diversification, making the results easier to understand.

[18] Following Khandelwal et al. (2013), incumbents are defined as firms that exported in both before and after quota removal.

[19] A firm's market share is calculated by its exports in China's exports. The market share is value-based to ensure the additivity of various product categories.

Table 10: Alternative explanation: quota misallocation

	EI_{cjt}			EI_{hjt}		
	SOE	Incumbents		SOE	Incumbents	
		Market share↑	Market share↓		Market share↑	Market share↓
	(1)	(2)	(3)	(4)	(5)	(6)
$QP_{cj} \times POST_t$	-0.40***	-0.44***	-0.43***			
	(-16.51)	(-19.76)	(-35.09)			
$QC_{hj} \times POST_t$				-0.01**	-0.04***	-0.04***
				(-2.28)	(-4.16)	(-8.61)
Destination-Year FE	Yes	Yes	Yes	No	No	No
Product-Year FE	No	No	No	Yes	Yes	Yes
Firm-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Destination-Firm FE	Yes	Yes	Yes	No	No	No
Product-Firm FE	No	No	No	Yes	Yes	Yes
Observations	178,715	326,110	511,649	769,784	792,746	1,510,745
R-squared	0.79	0.78	0.79	0.72	0.76	0.72

Notes. This table replicates the baseline regressions from Table 3 (Table 6) following Eq. (28) (Eq. (32)) on alternative samples. Sample in Columns (1) and (4): exports of 8-digit HS products from state-owned enterprises (SOEs) in our sample to the top 50 destinations. Sample in Columns (2), (3), (5), and (6): incumbents, i.e., firms that exported textile products in both 2000–2004 and 2005–2007. Incumbents in Columns (2) and (5) ((3) and (6)) had larger (smaller) average market shares in 2005–2007 than 2000–2004. In Columns (1)–(3), the dependent variable is the entropy index across products (EI_{cjt}), and the key explanatory variable in the interaction between QP_{cj} and $POST_t$, where QP_{cj} is the average share of quota-bound products in firm j's exports to destination c over 2000–2004 and $POST_t$ is a time indicator that equals one if $t > 2004$ and zero otherwise. Separate QP_{cj} and $POST_t$ are omitted due to collinearity. In Columns (4)–(6), the dependent variable is the entropy index across destinations (EI_{hjt}), and QC_{hj} is the average share of quota-bound destinations in firm j's exports of product h over 2000–2004. Separate QC_{hj} and $POST_t$ are omitted due to collinearity. Robust standard errors are reported in parenthesis. Significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 11: Impacts of quota removal on firms' stock market performances

Panel A. Dynamic effect

	AR				CAR			
Event window	(-1,1) (1)	(-1,5) (2)	(-1,10) (3)	(-1,22) (4)	(-1,1) (5)	(-1,5) (6)	(-1,10) (7)	(-1,22) (8)
$Treat_j$	5.33***	1.64	0.36	0.06	9.77***	9.17***	3.13*	0.82
	(3.49)	(0.81)	(0.24)	(0.07)	(8.36)	(6.44)	(1.79)	(0.21)
Daily FE	Yes	Yes	Yes	Yes	No	No	No	No
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	211	483	815	1,663	71	71	71	71
R-squared	0.11	0.06	0.03	0.04	0.16	0.13	0.03	0.03

Panel B. Three-day window

	AR (-1,1)		CAR (-1,1)	
	(1)	(2)	(3)	(4)
$Treat_j$	5.59***	5.26***	10.78***	9.77***
	(3.11)	(2.76)	(4.28)	(3.11)
Log(Asset)	0.36*	0.38	1.07	1.14
	(1.69)	(1.27)	(1.44)	(1.01)
Book-to-market ratio	-0.47	-1.43	-1.40	-4.29
	(-0.23)	(-0.68)	(-0.19)	(-0.55)
SOE		0.63		1.89
		(1.07)		(0.83)
Lerner Index		-3.14		-9.43
		(-1.25)		(-1.01)
Sales-to-price ratio		0.09		0.27
		(0.09)		(0.10)
Debt-to-equity ratio		0.24		0.72
		(0.53)		(0.48)
Age		-0.03		-0.08
		(-0.27)		(-0.23)
Daily FE	Yes	Yes	No	No
Industry FE	Yes	Yes	Yes	Yes
Observations	161	161	54	54
R-squared	0.19	0.21	0.21	0.28

Notes. This table reports the effects of the quota removal announcement on April 15, 1994, on the stock returns of affected firms, estimated with the event study in Eqs. (37) and (38). Sample: daily stock price data from January 1, 1994 to December 31, 1996; Chinese listed firms in the textiles, retail and wholesale trade, and conglomerates industries as the treatment group ($Treat_j = 1$) and those in other light industries as the control group ($Treat_j = 0$). In Panel A, Columns (1)–(4) focus on abnormal returns (AR) within an event window of (-1,1), (-1,5), (-1,10), and (-1,22), respectively. Abnormal returns are obtained with the FF-5 factor model multiplied by 100. Columns (5)–(8) report similar regressions with cumulative abnormal returns (CAR) as the dependent variable. Panel B focuses on the AR and CAR within the three-day event window and includes other firm characteristics, namely the log total assets, book-to-market ratio, SOE which equals one if the firm is state-owned and zero otherwise, individual Lerner Index (the gap between operating revenues and costs divided by operating revenues), sales-to-price ratio (revenue from main business divided by total market capitalization), debt-to-equity ratio (total liabilities divided by total owner's equity), and the age of the firm. The treatment variable $Treat_j$ indicates whether the industry of firm j is largely affected by quota removal. Robust standard errors are in parentheses. Significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Using daily stock price data of all trading days between January 1, 1994, and December 31, 1996, we employ the FF-5 factor model proposed by Fama and French (2015) to estimate the treatment effect of affected firms following Amiti et al. (2021). Specifically, we construct the abnormal returns (AR) and cumulative abnormal returns (CAR) to measure each firm's stock market performance through the following specification:

$$r_{jt} = \eta_j + \sum_{k=1}^{K=5} \kappa_{kj}\delta_{kt} + \varepsilon_{jt}, \tag{36}$$

where

$$\varepsilon_{jt} \equiv \gamma Treat_j \times D_t + \upsilon_{jt}. \tag{37}$$

or

$$\sum_{t=-1}^{T=w} \varepsilon_{jt} \equiv \gamma Treat_j + \upsilon_j. \tag{38}$$

Here, r_{jt} is the daily stock returns on day t, κ_{kj} is the loading of factors δ_{kt} in the FF-5 factor model. D_t is an indicator variable that equals one if day t falls within the announcement event window (-1,w) of quota removal and zero otherwise. The treatment variable $Treat_j$ is used to identify whether firm j was directly affected by quota removal.[20] ε_{jt} represents the AR and $\sum_{t=-1}^{T=w} \varepsilon_{jt}$ represents the CAR. After constructing AR and CAR by estimating Eq. (36), we then identify the average daily treatment effect of quota removal within the event window through coefficient γ in Eqs. (37) and (38).

Panel A of Table 11 reports the treatment effect of quota removal on AR and CAR of the affected Chinese listed firms estimated with different event windows around the quota removal announcement on April 15, 1995. As shown in Column (1), the AR of affected firms experiences a relative increase of 5% compared to that of unaffected firms within the three-day event window around April 15, 1994. Columns (2)–(4) indicate that the treatment effect diminishes as we extend the event window. Columns (5)–(8) also report consistent results when analyzing CAR. In summary, the quota removal announcement has a short-term positive and statistically significant effect on the stock returns of firms directly affected by quota removal.

Further, we focus on the three-day event window and introduce more firm characteristics as controls following Huang et al. (2023). Our controls include the log total assets, book-to-market ratio, SOE dummy, individual Lerner Index, sales-to-price ratio, and debt-to-equity ratio to account for firms'

[20] Due to the absence of firm-level detailed export data in 1995, we categorize firms into treatment and control groups based on their industries. The treatment group includes firms belonging to the top three industries sorted by the number of firms exporting quota-bound products in 2004, namely textiles, retail and wholesale trade, and conglomerates industries. Firms belonging to other light industries are chosen as the control group due to their similarity with the treatment group.

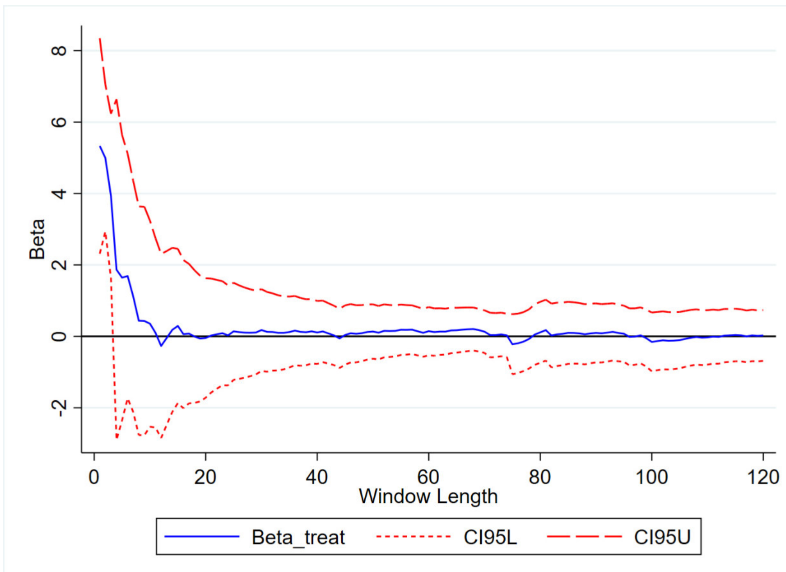

Figure 5: Treatment effect of quota removal in the long term

Notes: This figure reports the duration of stock price effects of quota removal. The dependent variable is AR (multiplied by 100) estimated by the FF-5 factor model across event windows from (-1,1) to (-1,120). The solid blue line represents the point estimate of the effect of quota removal on affected firms, and the dotted red line labeled with "CI95L" ("CI95U") represents the 95% lower (upper) confidence limit of the point estimate.

Source: Authors' event study estimation following Eq. (38) across different event windows with daily stock price data of Chinese listed firms from January 1, 1994 to December 31, 1996.

size, valuation, business nature, competitiveness, investment value, and leverage level. When accounting for the above controls, Panel B of Table 11 still reports positive coefficients for AR and CAR, supporting the robustness of our results.

Finally, we investigate the duration of the positive stock price effect by extending the event window from 3 days to 120 days. The results with AR as the dependent variable are presented in Figure 5, which indicates that the short-term coefficients are significantly positive. However, the positive effect is short-lived and becomes insignificant after 4 days, which is consistent with Table 11. After 14 days, the coefficients fluctuate slightly around zero.

7 Conclusion

In this paper, we examine how MPFs adjust their export strategies on both the product and destination levels following quota removal. Theoretically, we extend the oligopolistic equilibrium model of MFPs in Eckel and Neary (2010) by incorporating continuous trade barriers and multiple heterogeneous destinations. When quotas imposed on target products are removed in one destination, it can affect other products and destinations through demand and supply linkages within MPFs. On the demand side, when quota removal occurs, the export of quota-bound products increases, which cannibalizes and reduces the export of quota-free products, ultimately causing an export shift from quota-free products to quota-bound products. On the supply side, quota removal increases total labor requirements and thus wages, referred to as the capacity constraint effect, which forces MPFs to focus on their core competencies and shift their exports from quota-free countries to quota-bound ones.

In the context of the phase-out of the MFA, we use detailed export data from China Customs to explore MPFs' intra-firm adjustments after removing the externally imposed quotas on China's textile and clothing exports, providing empirical evidence for our theoretical predictions. Specifically, we find that quota removal leads to a reduction in product and destination diversification. This specialization is accompanied by an export skew from quota-free products and destinations toward quota-bound ones. After controlling for the supply force, we demonstrate that the cannibalization effect plays an important role in the export skew across products. We also explore heterogeneous export responses across products due to the capacity constraint effect and have two important findings. (i) The increase in exports of quota-bound products is primarily driven by MPFs' core competencies. (ii) The reduction in destination diversification is mainly driven by marginal varieties. The capacity constraint effect of removing textile quotas even negatively affects the exports of non-textile products to non-OECD countries. Furthermore, we demonstrate that our main results arise from removing the quota itself rather than eliminating the misallocation of quota licenses. Finally, we rely on stock market data to study the expected profit effect and find positive gains from export specialization after quota removal.

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8 Appendix: Theory

8.1 A1. Industry Equilibrium in Country 1

First case: $\boldsymbol{\lambda_Q > 0,\ \lambda_\delta = 0}$

From Eq. (16), we can get the expression of λ_Q:

$$\lambda_Q = a' - w\mu_\gamma(\delta_1^b) - b_1'e(Y_1 + X_1) - 2b_1'(1-e)\frac{Q}{m\delta_1^b}. \tag{A1}$$

Substituting Eq. (A1) into Eq. (14), the first-order condition for the scope of quota-bound products can be rewritten as:

$$w\gamma(\delta_1^b) = w\mu_\gamma(\delta_1^b) + 2b_1'(1-e)\frac{Q}{m\delta_1^b}. \tag{A2}$$

Completely differentiating the equilibrium condition in Eq. (A2) gives:

$$d\ln\delta_1^b = \frac{2b_1'(1-e)}{w\delta_1^b\gamma_\delta(\delta_1^b)}\frac{Q}{m\delta_1^b}(d\ln Q - d\ln w). \tag{A3}$$

Substituting Eq. (A1) into Eq. (8) gives another expression of export scale for a given quota-bound variety i:

$$x_1(i) = \frac{w\left[\mu_\gamma(\delta_1^b) - \gamma(i)\right]}{2b_1'(1-e)} + \frac{Q}{m\delta_1^b}. \tag{A4}$$

Completely differentiating Eq. (A4), we can get the change in the export of a given quota-bound product to country 1:

$$dx_1(i) = \frac{Q}{m\delta_1^b}d\ln Q + \frac{w\left[\mu_\gamma(\delta_1^b) - \gamma(i)\right]}{2b_1'(1-e)}d\ln w,\ i \in \left[0, \delta_1^b\right]. \tag{A5}$$

Substitute the relationship $X_1 = \frac{Q}{m} + X_1^f$ into Eq. (17), and the expression of X_1^f can be written as:

$$X_1^f = \frac{\left[a' - b_1'e(\frac{Q}{m} + Y_1) - w\mu_\gamma(\delta^*, \delta_1^f)\right](\delta_1^f - \delta^*)}{2b_1'(1-e) + b_1'e(\delta_1^f - \delta^*)}. \tag{A6}$$

We assume that the industry aggregate consumption in country c remains constant, consistent with country c's constant individual income and population in Eq. (4). Differentiating the export scale of all quota-free products in Eq. (A6) with given Y_1 gives:

$$dX_1^f = -\frac{\delta_1^f - \delta^*}{2b_1^{'}(1-e) + b_1^{'}e(\delta_1^f - \delta^*)}\left[\frac{b_1^{'}eQ}{m}d\ln Q + w\mu_\gamma(\delta^*, \delta_1^f)d\ln w\right]. \tag{A7}$$

As for the change in individual export scale for a given quota-free variety i ($i > \delta^*$), differentiating Eq. (9) with given Y_1 and combining it with Eq. (A7) gives:

$$dx_1(i) = -\frac{\frac{b_1^{'}eQ}{m}d\ln Q + \left\{\gamma(i) + \frac{e(\delta_1^f - \delta^*)\left[\gamma(i) - \mu_\gamma(\delta^*, \delta_1^f)\right]}{2(1-e)}\right\}wd\ln w}{2b_1^{'}(1-e) + b_1^{'}e(\delta_1^f - \delta^*)}, i \in \left[\delta^*, \delta_1^f\right]. \tag{A8}$$

Differentiating the first-order condition for the export scope of quota-free products in Eq. (15) and combining it with (A7), we can get the change in δ_1^f:

$$d\ln\delta_1^f = -\frac{2b_1^{'}e(1-e)\frac{Q}{m}d\ln Q + \left\{2(1-e)\gamma(\delta_1^f) + e(\delta_1^f - \delta^*)\left[\gamma(\delta_1^f) - \mu_\gamma(\delta^*, \delta_1^f)\right]\right\}wd\ln w}{w\delta_1^f\gamma_\delta(\delta_1^f)\left[2(1-e) + e(\delta_1^f - \delta^*)\right]}. \tag{A9}$$

Quota relaxation directly increases exports of quota-bound products and indirectly decreases exports of quota-free products. The change in the aggregate export of all products is:

$$dX_1 = \frac{Q}{m}d\ln Q + dX_1^f = \frac{2b_1^{'}(1-e)\frac{Q}{m}d\ln Q - w(\delta_1^f - \delta^*)\mu_\gamma(\delta^*, \delta_1^f)d\ln w}{2b_1^{'}(1-e) + b_1^{'}e(\delta_1^f - \delta^*)}. \tag{A10}$$

The firm's operating profit in country 1 is $\Pi_1 = \int_0^{\delta_1^b}\left[p_1(i) - w\gamma(i)\right]x_1(i)di + \int_{\delta^*}^{\delta_1^f}\left[p_1(i) - w\gamma(i)\right]x_1(i)di$. From Eqs. (6) and (7), the profit margin of a given quota-bound product $i \in \left[0, \delta_1^b\right]$, $p_1(i) - w\gamma(i)$, can be rewritten as $b_1^{'}\left[(1-e)x_1(i) + eX_1\right] + \lambda_Q$, and that of a given quota-free product $i \in \left[\delta^*, \delta_1^f\right]$ can be rewritten as $b_1^{'}\left[(1-e)x_1(i) + eX_1\right]$. Substitute these equations into the expression of Π_1, we can get another expression of the firm's operating profits in country 1:

$$\Pi_1 = \lambda_Q\frac{Q}{m} + b_1^{'}(1-e)\left[\int_0^{\delta_1^b}x_1^2(i)di + \int_{\delta^*}^{\delta_1^f}x_1^2(i)di\right] + b_1^{'}eX_1^2. \tag{A11}$$

We differentiate Eq. (A11) to determine the change in operating profits Π_1. Partially differentiating Π_1 with respect to the export scopes of quota-bound and quota-free products, δ_1^b and δ_1^f, gives: $\frac{\partial\Pi_1}{\partial\delta_1^b} = \left[p_1(\delta_1^b) - w\gamma(\delta_1^b)\right]x_1(\delta_1^b) = 0$ and $\frac{\partial\Pi_1}{\partial\delta_1^f} = \left[p_1(\delta_1^f) - w\gamma(\delta_1^f)\right]x_1(\delta_1^f) = 0$. The envelope theorem indicates that when δ_1^b and δ_1^f are optimally chosen, the expression of Π_1 is independent of export scopes. Once again, we can derive the change in Π_1 without considering δ_1^b and δ_1^f explicitly. Combine Eqs. (A1), (A5), (A8) and (A10) with the derivative of Π_1, and then we can get that the demand effect has a positive effect on Π_1 while the supply-side capacity constraint effect has a negative effect on Π_1. This is given by:

$$\begin{aligned} d\Pi_1 = &\left[\lambda_Q + 2b_1^{'} e X_1^f \frac{2(1-e)}{2(1-e)+e(\delta_1^f - \delta^*)}\right] \frac{Q}{m} d\ln Q \\ &- \left[2eX_1^f \frac{(\delta_1^f - \delta^*)\mu_\gamma(\delta^*, \delta_1^f)}{2(1-e)+e(\delta_1^f - \delta^*)} + l_1\right] w d\ln w, \end{aligned} \tag{A12}$$

where $l_1 = \int_0^{\delta_1^b} x_1(i)\gamma(i)di + \int_{\delta^*}^{\delta_1^f} x_1(i)\gamma(i)di$ denotes the aggregate labor requirements to produce all products exported to country 1.

Second case: $\lambda_\mathbf{Q} > \mathbf{0}$, $\lambda_\delta > \mathbf{0}$

In the second case, Eqs. (A1) (A4)-(A10) and (A11)-(A12) still holds with δ_1^b equal to δ^*. However, the export of marginal quota-bound variety is positive, and the first-order condition for δ_1^b in Eq. (A2) does not hold. The export scope of quota-bound products δ_1^b equals the exogenously determined δ^*. The change in δ_1^b with respect to an infinitesimal increase in quota is zero. The change in the export scope of all products equals that of quota-free products, i.e., $d\delta_1 = d\delta_1^f$.

8.2 A2. Industry Equilibrium in Country 2

We then discuss the firm's decisions regarding the scale and scope of their exports to country 2. The first-order conditions of the profit maximization problem in Eq. (5) with respect to export scale and scope in country 2 are listed as follows:

$$\frac{\partial L}{\partial x_2(i)} = p_2(i) - w\gamma(i) - b_2^{'}\left[(1-e)x_2(i) + eX_2\right] = 0, \tag{A13}$$

$$\frac{\partial L}{\partial \delta_2} = \left[p_2(\delta_2) - w\gamma(\delta_2)\right] x_2(\delta_2) = 0. \tag{A14}$$

Combining Eqs. (4) and (A13), the export of a given variety i to country 2, $x_2(i)$, is given by:

$$x_2(i) = \frac{a^{'} - w\gamma(i) - b_2^{'} e(Y_2 + X_2)}{2b_2^{'}(1-e)}, \tag{A15}$$

where $X_2 \equiv \int_0^{\delta_2} x_2(i)di$ denotes the firm's total export to country 2 and Y_2 denotes the industry aggregate consumption in country 2.

Eq. (A13) indicates that the export profit margin of the marginal variety exported to country 2, $p_2(\delta_2) - w\gamma(\delta_2)$, is positive. Eq. (A14) thus implies $x_2(\delta_2) = 0$. Combining with Eq. (A15), the first-order condition for δ_2 can be rewritten as:

$$w\gamma(\delta_2) = a' - b_2'(Y_2 + X_2). \tag{A16}$$

Eq. (A16) gives one relationship between export scale X_2 and scope δ_2. Integration over Eq. (A15) for the firm's total export scale to country 2 gives another relationship:

$$X_2 = \int_0^{\delta_2} x_2(i)di = \frac{\left[a' - w\mu_\gamma(\delta_2) - b_2' e(Y_2 + X_2)\right]\delta_2}{2b_2'(1-e)}. \tag{A17}$$

Differentiating Eq. (A17) with given Y_1 gives:

$$dX_2 = -\frac{w\delta_2\mu_\gamma(\delta_2)}{2b_2'(1-e) + b_2'\delta_2} d\ln w. \tag{A18}$$

Differentiating Eq. (A15) with given Y_1 and combining it with Eq. (A18) gives the change in individual product export to country 2:

$$dx_2(i) = \frac{e\delta_2\mu_\gamma(\delta_2) - \left[2(1-e) + e\delta_2\right]\gamma(i)}{2b_2'(1-e)\left[2(1-e) + e\delta_2\right]} wd\ln w. \tag{A19}$$

Differentiating the first-order condition for export scope δ_2 in Eq. (A16) with given Y_1 and combining it with Eq. (A18) gives the change in δ_2:

$$d\ln\delta_2 = -\frac{1}{\delta_2\gamma_\delta(\delta_2)}\left[\gamma(\delta_2) - \frac{e\delta_2}{2(1-e) + e\delta_2}\mu_\gamma(\delta_2)\right] d\ln w. \tag{A20}$$

The firm's operating profit in country 2 is $\Pi_2 = \int_0^{\delta_2}\left[p_2(i) - w\gamma(i)\right]x_2(i)di$. From Eq. (A13), the profit margin, $p_2(i) - w\gamma(i)$, can be rewritten as $b_2'\left[(1-e)x_2(i) + eX_2\right]$. Substitute it into the expression of operating profit in country 2, we can get another expression of Π_2:

$$\Pi_2 = b_2'\left[(1-e)\int_0^{\delta_2} x_2^2(i)di + eX_2^2\right]. \tag{A21}$$

To determine the change in operating profit Π_2, we differentiate Eq. (A21), using the derivatives of X_2 and $x_2(i)$ from Eqs. (A18) and (A19) to substitute for dX_2 and $dx_2(i)$. This gives:

$$d\Pi_2 = b_2^{'}\left[2(1-e)\int_0^{\delta_2} x_2(i)dx_2(i)di + 2eX_2dX_2\right] = -\left[\frac{e\delta_2\mu_\gamma(\delta_2)X_2}{2(1-e)+e\delta_2} + l_2\right] wd\ln w, \tag{A22}$$

where $l_2 = \int_0^{\delta_2} x_2(i)\gamma(i)di$ denotes the labor requirements to produce all products exported to country 2.

8.3 A3. Quotas Imposed on Marginal Varieties

We now discuss the effects of quota removal when a quota restriction is imposed on marginal varieties. In this case, the product line split is exactly the opposite of the previous in Section 3. The range of quota-free products is denoted by $[0, \delta^*]$. Any products behind δ^* are quota-bound. We also assume that the optimal possible export of product δ^* without quotas is positive, ensuring the quota restriction is effective. Specifically, restrictions imposed on products that firms do not export, even in the no-quota situation, do not work. δ_1^f and δ_1^b are the export scope of quota-free and quota-bound products. The quota restriction for each MFP can be written as $\int_{\delta^*}^{\delta_1^b} x_1(i) \leq \frac{Q}{m}$.

The profit maximization subject to quota constraints of a representative MFP exporting to countries 1 and 2 can be written as:

$$\begin{aligned} max\ \Pi = & \int_0^{\delta_1^f} \left[p_1(i) - w\gamma(i)\right] x_1(i)di + \int_{\delta^*}^{\delta_1^b} \left[p_1(i) - w\gamma(i)\right] x_1(i)di - wf_1 \\ & + \int_0^{\delta_2} \left[p_2(i) - w\gamma(i)\right] x_2(i)di - wf_2 \\ s.t. & \int_{\delta^*}^{\delta_1^b} x_1(i) \leq \frac{Q}{m} \\ & \delta_1^f \leq \delta^*. \end{aligned} \tag{A23}$$

The first-order conditions of the profit maximization problem in Eq. (A23) with respect to the export scale of quota-bound and quota-free products to country 1 are listed as follows:

$$\frac{\partial L}{\partial x_1(i)} = p_1(i) - w\gamma(i) - b_1^{'}\left[(1-e)x_1(i) + eX_1\right] = 0, i \in \left[0, \delta_1^f\right], \tag{A24}$$

$$\frac{\partial L}{\partial x_1(i)} = p_1(i) - w\gamma(i) - b_1^{'}\left[(1-e)x_1(i) + eX_1\right] - \lambda_Q = 0, i \in \left[\delta^*, \delta_1^b\right]. \tag{A25}$$

$X_1 \equiv \int_0^{\delta_1^f} x_1(i)di + \int_{\delta^*}^{\delta_1^b} x_1(i)di$ is the firm's total export to country 1. Let $X_1^f \equiv \int_0^{\delta_1^f} x_1(i)di$ denote the total exports of quota-free products and $X_1^b \equiv \int_{\delta^*}^{\delta_1^b} x_1(i)di$ denote the total exports of quota-bound products. Combining Eqs. (4), (A24) and (A25), the export scale of a given quota-free or quota-bound product is given by:

$$x_1(i) = \frac{a' - w\gamma(i) - b_1' e(Y_1 + X_1)}{2b_1'(1-e)}, i \in \left[0, \delta_1^f\right], \tag{A26}$$

$$x_1(i) = \frac{a' - w\gamma(i) - \lambda_Q - b_1' e(Y_1 + X_1)}{2b_1'(1-e)}, i \in \left[\delta^*, \delta_1^b\right]. \tag{A27}$$

The first-order conditions with respect to the export scope of quota-free and quota-bound products to country 1 are given by:

$$\frac{\partial L}{\partial \delta_1^f} = \left[p_1(\delta_1^b) - w\gamma(\delta_1^b)\right] x_1(\delta_1^f) - \lambda_\delta = 0, \tag{A28}$$

$$\frac{\partial L}{\partial \delta_1^b} = \left[p_1(\delta_1^b) - w\gamma(\delta_1^b) - \lambda_Q\right] x_1(\delta_1^b) = 0. \tag{A29}$$

The complementary slackness conditions for the two constraints are:

$$\lambda_Q \left[\frac{Q}{m} - \int_{\delta^*}^{\delta_1^b} x_1(i)di\right] = 0, \tag{A30}$$

$$\lambda_\delta \left[\delta^* - \delta_1^f\right] = 0. \tag{A31}$$

When there is a quota restriction, MPFs' total exports are lower than their optimal level without any restrictions. Combined with our assumption of constant Y_1, Eq. (A26) shows that the export scale of quota-free products is larger than that in the no-quota situation. The optimal individual exports of all quota-free products without quotas are all positive. Thus, we can get $x_1(i) > 0$ for $i \in [0, \delta^*]$. Eqs. (A28) and (A31) indicate that $\lambda_\delta > 0$ and $\delta_1^f = \delta^*$. In summary, MPFs export all quota-free products, and quota removal will not influence the export scope of quota-free products to the quota-bound destination.

Integrating Eqs. (A28) and (A29) for the firm's total export scale of quota-free and quota-bound products yields another two relationships:

$$X_1^f = \int_0^{\delta^*} x_1(i)di = \frac{\left[a' - w\mu_\gamma(\delta^*) - b_1' e(Y_1 + X_1)\right]\delta^*}{2b_1'(1-e)}, \tag{A32}$$

$$X_1^b = \frac{Q}{m} = \int_{\delta^*}^{\delta_1^b} x_1(i)di = \frac{\left[a' - w\mu_\gamma(\delta^*, \delta_1^b) - \lambda_Q - b_1' e(Y_1 + X_1)\right]\left(\delta_1^b - \delta^*\right)}{2b_1'(1-e)}. \tag{A33}$$

Combining Eq. (A33) and $X_1^b = \frac{Q}{m}$, we can get the expression of λ_Q:

$$\lambda_Q = a' - w\mu_\gamma(\delta^*, \delta_1^b) - b_1' e(Y_1 + X_1) - 2b_1'(1-e)\frac{Q}{m(\delta_1^b - \delta^*)}. \tag{A34}$$

From Eq. (A29), we can get that the export scale of marginal quota-bound variety is zero. Substituting $x_1(\delta_1^b) = 0$ and Eq. (A11) into Eq. (A27), we can rewrite the first-order condition for δ_1^b in Eq. (A29) as:

$$w\gamma(\delta_1^b) = w\mu_\gamma(\delta^*, \delta_1^b) + 2b_1'(1-e)\frac{Q}{m(\delta_1^b - \delta^*)}. \tag{A35}$$

Totally differentiating Eq. (A35) gives the change in export scope of quota-bound products:

$$d\ln\delta_1^b = \frac{2b_1'(1-e)Q}{m(\delta_1^b - \delta^*)w\delta_1^b\gamma_\delta(\delta_1^b)}(d\ln Q - d\ln w). \tag{A36}$$

We can rewrite Eq. (A32) as:

$$X_1^f = \frac{\left[a' - w\mu_\gamma(\delta^*) - b_1' e(Y_1 + \frac{Q}{m})\right]\delta^*}{2b_1'(1-e) + b_1' e\delta^*}. \tag{A37}$$

Differentiating Eq. (A38) gives the change in total export scale of quota-free products to the quota-bound destination:

$$dX_1^f = \frac{-w\delta^*\mu_\gamma(\delta^*)d\ln w - b_1' e\delta^*\frac{Q}{m}d\ln Q}{2b_1'(1-e) + b_1' e\delta^*}. \tag{A38}$$

Note that we also take the total consumption in the destination market, Y_1, as constant. The cannibalization and capacity constraint effects of quota relaxation both decrease exports of quota-free products.

We then turn to the response of the individual export scale of a particular variety. First, we consider the individual export of a quota-free variety i ($i \in [0, \delta^*]$). Differentiating Eq. (A26), we can get:

$$dx_1(i) = -\frac{eQ}{\left[2(1-e) + e\delta^*\right]m}d\ln Q - \frac{\left[\gamma(i) - \frac{e\delta^*}{2(1-e)+e\delta^*}\mu_\gamma(\delta^*)\right]w}{2b_1'(1-e)}d\ln w, i \in [0, \delta^*]. \tag{A39}$$

The first term on the right side is the cannibalization effect, which leads to a uniform decrease in the export scale of each quota-free variety. The second term represents the capacity constraint effect, which pivots the export quantity curve clockwise around the threshold variety whose labor requirement is $\frac{e\delta^*}{2(1-e)+e\delta^*}\mu_\gamma(\delta^*)$. For quota-free variety with $\gamma(i)$ lower (larger) than $\frac{e\delta^*}{2(1-e)+e\delta^*}\mu_\gamma(\delta^*)$, its export scale increases (decreases) with a higher wage after quota removal. In other words, the capacity constraint effect encourages MPFs to focus on their core competence. Second, we discuss the change in the individual export of a quota-bound variety i ($i \in (\delta^*, \delta_1^b]$). Substituting the expression of λ_Q in Eq. (A34) into Eq. (A26), we will get:

$$dx_1(i) = \frac{Q}{m(\delta_1^b - \delta^*)} d\ln Q + \frac{\left[\mu_\gamma(\delta^*, \delta_1^b) - \gamma(i)\right] w}{2b_1'(1-e)} d\ln w, i \in \left[\delta^*, \delta_1^b\right]. \tag{A40}$$

As previously stated, the market-size effect leads to a uniform increase in the export scale of each quota-bound variety, whereas the capacity constraint effect is product-heterogeneous. The latter pivots the export quantity curve clockwise and encourages MPFs to be specialized.

We then turn to the labor market equilibrium to identify the existing condition for the capacity constraint effect. Differentiating the labor market equilibrium condition, we can get the change in the wage due to quota relaxation:

$$\frac{d\ln w}{d\ln Q} = \frac{\left[\mu_\gamma(\delta^*, \delta_1^b) - \frac{e\delta^*}{2(1-e)+e\delta^*}\mu_\gamma(\delta^*)\right]\frac{Q}{m}}{\frac{w(\delta_1^b-\delta^*)\sigma_\gamma^2(\delta^*,\delta_1^b)}{2b_1'(1-e)} + \frac{2(1-e)w\delta^*\mu_\gamma''(\delta^*)+ew(\delta^*)^2\sigma_\gamma^2(\delta^*)}{2b_1'(1-e)\left[2(1-e)+e(\delta_1^f-\delta^*)\right]} + \frac{2(1-e)w\delta_2\mu_\gamma''(\delta_2)+ew\delta_2^2\sigma_\gamma^2(\delta_2)}{2b_2'(1-e)[2(1-e)+e\delta_2]}}. \tag{A41}$$

Similar to Section 3.5, if the labor requirement increase induced by the market-size effect is larger than the labor requirement decrease induced by the cannibalization effect, i.e., $\mu_\gamma(\delta^*, \delta_1^b) > \frac{e\delta^*}{2(1-e)+e\delta^*}\mu_\gamma(\delta^*)$, quota relaxation will raise the equilibrium wage and generate the capacity constraint effect.

The effects of quota removal when imposing restrictions on marginal varieties are summarized in Figure A1. Consistent with the situation when restrictions are imposed on core varieties, the demand forces shift the export quantity curve of quota-bound (quota-free) products upward (downward). The capacity constraint effect from the supply side makes the export quantity curve steeper. The main difference is the change in the export scope of quota-bound and quota-free products to country 1. Quota removal has no influence on the export scope of quota-free products. The change in the export scope of quota-bound products is ambiguous. As the export quantity curve becomes steeper, the export scope of quota-bound products may decrease after quota removal.

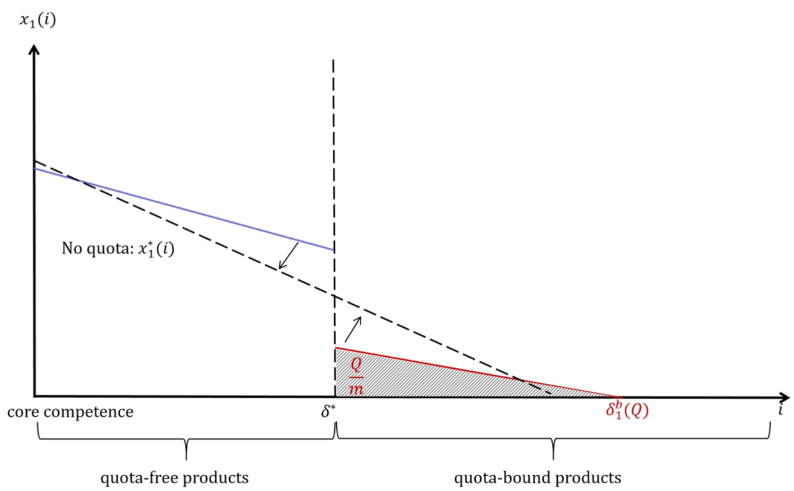

Figure A1: The effects of quota removal when imposing restrictions on marginal varieties

Notes: Red (Blue) lines represent the individual export of quota-bound (quota-free) products to country 1 with a quota equal Q. $x_1^*(i)$ denotes the potential optimal export of variety i to country 1 without quota constraints. The arrows indicate quota relaxation.

9 Appendix: Empirics

9.1 Tables

Table A1: Identification strategies for different tables

	Quota-bound destinations	Quota-free OECD countries	Non-OECD countries
Quota-bound products	A	D	G
Quota-free textile products	B	E	H
Non-textile products	C	F	I

Notes. This table reports the control and treatment groups in different regressions. Quota-free destinations include OECD and non-OECD countries, and quota-free products include textile and non-textile products. First, with yellow (A) as the treatment group and orange (B and C) as the control group, we focus on the quota-bound destinations and explore firms' adjustments across products in Tables 4 and 5. Second, with yellow and orange (A–C) as the treatment group and green (D–I) as the control group, we explore firms' adjustments across destinations in Table 7. Focusing on firms' non-textile exports to non-OECD countries (I), we conduct further analysis of the spillover effects of quota removal in Table 8.

Table A2: Firm linking between export data and stock market data

Industry name	Industry code	No. of export firms	No. of affected firms
Agriculture	A01	1	0
Fishery	A04	2	1
Farming, Forestry, Animal Husbandry, and Fishery	A05	1	1
Petroleum and Gas Extraction	B07	1	0
Farm Products Processing	C13	1	0
Wine, drinks and refined tea manufacturing	C15	1	0
Textile	C17	31	22
Textiles, Garments and Apparel industry	C18	13	11
Leather, fur, feathers, and related products and shoe-making	C19	2	1
Papermaking and Paper Products	C22	3	0
Printing and Reproduction of Recorded Media	C23	1	1
Petroleum Processing, Coking and Nuclear Fuel Processing	C25	1	1
Raw Chemical Materials and Chemical Products	C26	4	0
Pharmaceutical manufacturing	C27	8	3
Chemical Fibre Manufacturing	C28	14	2
Rubber and plastic product industry	C29	1	0
Non-metallic Mineral Products	C30	2	0
Smelting and Pressing of Ferrous Metals	C31	1	1
Smelting and Pressing of Nonferrous Metals	C32	1	0
Metal Products	C33	2	0
General Equipment Manufacturing	C34	2	0
Special Equipment Manufacturing	C35	1	0
Automobile Manufacturing	C36	2	0
Electric Machines and Apparatuses Manufacturing	C38	1	0
Computer, communication and other electronical device manufacturing	C39	6	2
Instrument and Meter Manufacturing	C40	1	0
Other Manufacturing	C41	3	1
Production and supply of electric power and thermal power	D44	2	2
Building Construction	E47	1	0
Civil Engineering Construction	E48	3	1
Wholesale	F51	2	1
Retail Trade	F52	36	25
Water Transportation	G55	1	1
Air Transportation	G56	1	1
Loading, unloading and transportation agency	G58	7	4
Real Estate	K70	2	1
Business Service	L72	1	1
Public Utility Management	N78	1	0
Other Service	O81	1	0
Conglomerates	S90	14	9
Total		179	93

Notes. This table reports each industry's firm-matching results between export data from China Customs and stock market data from the CSMAR database in 2004. The definition of industries follows the industry classification published by the China Securities Regulatory Commission in 2012. Export firms in this table refer to Chinese listed firms that are matched with any export transactions. Affected firms refer to those that exported quota-bound products to quota-bound destinations in 2004.

Table A3: Quota removal and intra-firm adjustments across products of all firms

Panel A. Export adjustments between quota-bound and quota-free products in quota-bound destinations

	Log(export) (1)	Export share (%) (2)	Log(export) (3)	Export share (%) (4)
$QPC_{hc} \times POST_t$	0.12^{***}	1.16^{***}	0.20^{***}	1.23^{***}
	(4.36)	(4.28)	(5.37)	(3.29)
Product-Destination-firm FE	Yes	Yes	Yes	Yes
Product-Year FE	Yes	Yes	Yes	Yes
Destination-Year FE	Yes	Yes	Yes	Yes
Product-Firm-firm FE	No	No	Yes	Yes
Observations	1,158,300	1,158,300	515,834	515,834
R-squared	0.76	0.84	0.90	0.94

Panel B. Heterogeneous export responses across varieties

	Log(export) (1)	Export value (million USD) (2)	Export share (%) (3)
$QPC_{hc} \times POST_t$	0.03	0.01	0.34
	(0.92)	(0.14)	(1.27)
$QPC_{hc} \times POST_t \times Core_{hj}$	0.79^{***}	0.87^{***}	7.03^{***}
	(17.13)	(14.71)	(10.40)
Product-Destination-firm FE	Yes	Yes	Yes
Product-Year FE	Yes	Yes	Yes
Destination-Year FE	Yes	Yes	Yes
Observations	1,158,300	1,158,300	1,158,300
R-squared	0.76	0.68	0.84

Notes. This table replicates the regressions from Table 4 on a larger sample with all firms included. Sample: annual exports of 8-digit HS products from all firms in our sample to 3 quota-bound destinations (including the United States, the European Union, and Canada). In Panel A, the dependent variables include firm j's log exports of product h to destination c (Columns (1) and (3)) and its share in firm j's total exports to destination c (Columns (2) and (4)). The key explanatory variable is the interaction between QPC_{hc} and $POST_t$, where QPC_{hc} equals one if Chinese exports of product h to destination c were subject to quotas before 2005 and zero otherwise. $POST_t$ equals one if year t is post-2004 and zero otherwise. Separate QPC_{hc} and $POST_t$ are omitted due to collinearity. In Panel B, the exports without log transformation are also added as the dependent variable in Column (2). The key explanatory variable is the triple interaction, where "$Core_{hj}$" is an indicator of core competence, equal to one if product h is the top product in firm j's exports in 2007 and zero otherwise. Separate QPC_{hc}, $POST_t$, and $Core_{hj}$ are omitted due to collinearity. Robust standard errors are reported in parenthesis. Significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A4: Heterogeneity across varieties: alternative definitions of core competence

Panel A. Top 2 products

	Log(export) (1)	Export value (million USD) (2)	Export share (%) (3)
$QPC_{hc} \times POST_t$	-0.01	-0.07***	2.01***
	(-0.22)	(-3.19)	(4.22)
$QPC_{hc} \times POST_t \times Core_{hj}$	0.82***	0.68***	4.99***
	(17.56)	(14.29)	(7.63)
Product-Destination-firm FE	Yes	Yes	Yes
Product-Year FE	Yes	Yes	Yes
Destination-Year FE	Yes	Yes	Yes
Observations	243,853	243,853	243,853
R-squared	0.71	0.65	0.81

Panel B. Top 3 products

	Log(export) (1)	Export value (million USD) (2)	Export share (%) (3)
$QPC_{hc} \times POST_t$	-0.04	-0.08***	2.08***
	(-1.01)	(-3.60)	(4.36)
$QPC_{hc} \times POST_t \times Core_{hj}$	0.78***	0.58***	3.68***
	(18.08)	(14.95)	(6.45)
Product-Destination-firm FE	Yes	Yes	Yes
Product-Year FE	Yes	Yes	Yes
Destination-Year FE	Yes	Yes	Yes
Observations	243,853	243,853	243,853
R-squared	0.71	0.64	0.81

Notes. This table replicates the regressions from Panel B of Table 4 with broader definitions of a firm's core competence. Sample: annual exports of 8-digit HS products from Chinese firms with at least 80% of exports attributed to textile products to 3 quota-bound destinations (including the United States, the European Union, and Canada). The dependent variables in Columns (1)–(3) are firm j's log exports of product h to destination c, the exports without log transformation, and the share of product h in firm j's total exports to destination c. The key explanatory variable is the triple interaction, where QPC_{hc} equals one if Chinese exports of product h to destination c were subject to quotas before 2005 and zero otherwise, $POST_t$ equals one if year t is post-2004 and zero otherwise, and $Core_{hj}$ an indicator of core competence. In Panel A (B), $Core_{hj}$ is equal to one if product h is among the top 2 (3) products in firm j's exports in 2007 and zero otherwise. Separate QPC_{hc}, $POST_t$, and $Core_{hj}$ are omitted due to collinearity. Robust standard errors are reported in parenthesis. Significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A5: Pre-reform difference-in-differences

	Product diversification			Destination diversification		
	No. of products	HI_{cjt}	EI_{cjt}	No. of destinations	HI_{hjt}	EI_{hjt}
	(1)	(2)	(3)	(4)	(5)	(6)
$QP_{cj} \times POST_t$	0.04^{*}	-0.02^{***}	0.08^{***}			
	(1.87)	(-2.80)	(4.83)			
$QC_{hj} \times POST_t$				0.07^{***}	-0.01^{***}	0.03^{***}
				(10.52)	(-4.86)	(6.02)
Destination-Year FE	Yes	Yes	Yes	No	No	No
Product-Year FE	No	No	No	Yes	Yes	Yes
Firm-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Destination-Firm FE	Yes	Yes	Yes	No	No	No
Product-Firm FE	No	No	No	Yes	Yes	Yes
Observations	297,991	297,991	297,991	824,534	824,534	824,534
R-squared	0.81	0.81	0.86	0.35	0.75	0.79

Notes. This table reports the placebo tests for our baseline results in Tables 3 and 6. Sample: annual exports of 8-digit HS quota- bound products from all firms in our sample to the top 50 destinations between 2000 and 2003. The year 2002 is set as a fake treatment time, i.e., $POST_t$ is equal to one if year t is post-2002 and zero otherwise. The dependent variable and each firm's exposure to quota removal in Columns (1)–(3) have been defined in Table 3, and those in Columns (4)–(6) have been defined in Table 6. Robust standard errors are reported in parenthesis. Significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

9.2 Figures

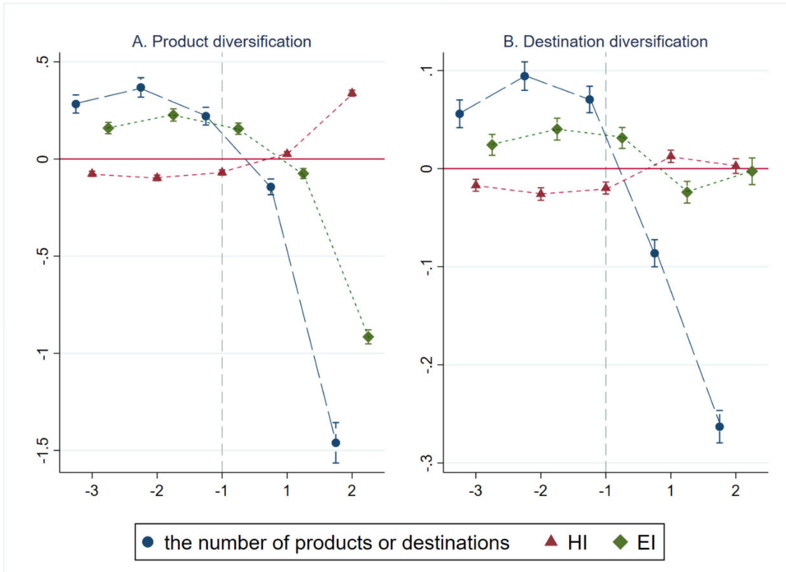

Figure A2: Dynamic treatment effect of quota removal

Notes: This figure reports the dynamic effects of quota removal estimated with Eq. (35), along with 95% confidence intervals. Panel A focuses on product diversification and uses the number of 8-digit HS products, HI_{cjt}, and EI_{cjt} as the dependent variable, respectively. Panel B focuses on destination diversification and uses the number of destinations, HI_{hjt}, and EI_{hjt} as the dependent variable, respectively.