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EVIDENCE FROM CHINESE EXPORTERS

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ABSTRACT

If trade barriers are managed by inefficient institutions, trade liberalization can lead to greater-than-expected gains. We examine Chinese textile and clothing exports before and after the elimination of externally imposed export quotas. We find that the surge in export value and decline in export prices following quota removal is driven by net entry, and show that this dominance is inconsistent with use of a productivity-based allocation of quota licenses by the Chinese government. Our counterfactual implies that elimination of misallocated quotas raised the overall productivity gain of quota removal by 28 percent.

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1 Introduction

Institutions that distort the efficient allocation of resources across firms can have a sizable effect on economic outcomes. Hsieh and Klenow (2009), for example, estimate that distortions in the Chinese economy reduce manufacturing productivity by 30 to 50 percent relative to an optimal distribution of capital and labor across existing manufacturers. While research in this area often concentrates on misallocation among existing firms, distortions can also favor incumbents at the expense of entrants. Trade barriers such as tariffs and quotas can obviously distort resource allocation along these “intensive” and “extensive” margins, and estimation of the productivity growth associated with their removal is a traditional line of inquiry in international trade. But gains from trade liberalization may be larger than expected if the institutions created to manage the barriers impose their own, additional drag on productivity. In that case, trade liberalization induces two gains: the first from the elimination of the embedded institution, and the second from the removal of the trade barrier itself.

In this paper, we examine productivity growth among Chinese exporters following the removal of externally imposed quotas. Under the global Agreement on Textile and Clothing, previously known (and referred to in this paper) as the Multifiber Arrangement (MFA), textile and clothing exports from China and other developing economies to the US, the EU and Canada were subject to quotas until January 1, 2005. In China, the licenses permitting firms to export a portion of the country’s overall quota were distributed by the government. We examine whether this allocation created an additional drag on exporter productivity.

Our assessment of the extent to which China assigned export licenses on the basis of firm productivity is guided by an “auction-allocation” model derived from Irarrazabal et al. (2010), who introduce per-unit tariffs into the heterogeneous-firm framework of Melitz (2003) and Chaney (2008). Here, we interpret the specific tariff as a (common) quota license fee which firms must pay in order to access restricted foreign markets. This fee equates the supply and demand for quota. Firms self-select into the quota-constrained export market based on their productivity, as only the most productive exporters remain profitable net of the fee.

In the auction-allocation model, removal of quotas gives rise to three empirically testable reactions. First, because per-unit license fees impose a greater distortion

on low-price goods, exports of the most productive incumbents jump relative to those of less productive incumbents. Second, because obtaining a costly export license is no longer necessary, low-productivity firms may enter the export market. Third, incumbents and entrants make opposing contributions to export prices: price declines among incumbents who no longer must pay a license fee are offset by the relatively high prices of low-productivity entrants. In all three of these reactions, the trends are dominated by incumbents.

We use firm-level Chinese customs data to compare the growth of previously quota-constrained Chinese textile and clothing goods to the growth of similar textile and clothing products exported quota free. This “difference-in-differences” comparison isolates the influence of quota allocation from other factors affecting Chinese textile and clothing exports more broadly. Shipments of “cotton slips” to the US, for example, were subject to quotas in 2004, while exports of “silk slips”, were not. Contrasting their growth in the years before and after quotas are removed controls for shocks to supply, such as privatization, and shocks to demand, such as changes in the preferences of consumers, that are plausibly common to both goods.

Substantial deviations between the auction-allocation model and the data indicate that the actual quota licenses assigned by the government were misallocated with respect to firm productivity.¹ We show that both the strong export growth and the sharp price declines associated with quota removal are driven by net entry rather than incumbents. More importantly, several trends indicate that entrants were *more* productive than incumbents. First, their prices were on average 25 percent and 21 percent lower than incumbents and exiters, respectively, such that net entrants accounted for 63 percent of the overall 18 percentage point decline in relative prices. Second, entrants tended to emerge from the private sector and gain market share at the expense of relatively unproductive incumbent state-owned enterprises (SOEs). Finally, incumbents with the highest market share under quotas experienced the largest decline in market share when quotas were removed. This outcome contrasts starkly with the model’s prediction that high-productivity

¹We recognize that quota “misallocation” with respect to firm productivity may reflect optimization with respect to other objectives of the government, such as balancing employment across regions in China. To the extent that such objectives were relevant, our results can be interpreted as measuring the cost of pursuing them in terms of exporter efficiency.

incumbents benefit disproportionately from the removal of license fees.²

In the second part of the paper we use results from our empirical analysis to estimate the overall growth in exporter productivity associated with quota removal as well as the contribution of eliminating misallocation. Inferring productivity growth from changes in firms' quality-adjusted export prices, we find that aggregate productivity among China's textile and clothing exporters rose 7 percent upon quota removal. This overall gain is large given that textiles and clothing represent 15 percent of China's exports and 13 percent of its manufacturing employment. To gauge the contribution of misallocation to this overall gain, we consider an alternate "political allocation" scenario in which the government assigns export licenses according to firms' "political connections" as well as their productivity. Comparison of calibrated solutions to the auction and political allocation scenarios implies that elimination of misallocated quotas raises the overall productivity gain of quota removal by 28 percent.

Our findings relate most directly to the growing set of papers that use microdata to estimate the effects of market distortions on existing firms (i.e., the "intensive" margin). These papers generally identify misallocation by comparing an outcome such as the firm-size or productivity distribution across countries, e.g., China versus the US.³ While this approach provides valuable insight, it is necessarily coarse: any deviation between outcomes is attributed to misallocation versus other differences between countries such as variation in product mix, technology or entrepreneurial ability. Bloom and van Reenen (2007), for example, show that the distribution of the latter may vary across counties if entrepreneurs in developing countries are slow to adopt best practices. Likewise, as noted in Syverson (2011), these aggregate comparisons do not identify the particular sources of distortions. Our contribution to these efforts is threefold. First, we analyze reallocation between existing and potential exporters. Second, we identify misallocation using relatively weak assumptions: our difference-in-differences strategy requires only that the distribution of technology and entrepreneurial ability be identical across similar

²We rely on indirect evidence of entrants' relative productivity because we do not have the data to measure exporters' TFP directly. See Section 4 for more detail.

³See, for example, Hsieh and Klenow (2009), Restuccia and Rogerson (2008), and Alfaro et al. (2008). Dollar and Wei (2007) investigate misallocation among Chinese firms by comparing the returns to capital across sectors and provinces in China.

types of textile and clothing products within China, e.g., silk versus cotton slips. Finally, our approach isolates the potential distortions caused by a specific policy, quota allocation.

The effect of distortions on the extensive margin (e.g., firm entry) is studied most widely in the context of credit constraints in developing countries. Banerjee and Duflo (2004), for example, use an exogenous change in the supply of credit to specific firms to identify constraints on obtaining credit among Indian firms. Their results suggest the existence of talented entrepreneurs who are prevented from establishing firms due to their inability to borrow from the formal banking sector. Our contribution relative to these efforts is to gather data on a specific distortion affecting the extensive margin, and to use it to estimate its effects. We find that the Chinese government prevented the most productive Chinese textile and clothing firms from entering the export market, substantially reducing aggregate productivity. To the extent that such restrictions were present in other export markets, the economy-wide productivity loss associated with suppression of the extensive margin (via barriers to entry) might have been quite large given the importance of exports in China's growth.

Finally, our results contribute to a large literature examining the costs of trade protection.⁴ Standard analyses of these costs ignore misallocation along the extensive margin. An exception is Anderson (1985), who shows that the deadweight loss associated U.S. cheese quotas is understated if they are not assigned to the lowest-cost countries. Our study is conceptually similar to Glaeser and Luttmer's (2003) examination of rent controls in the New York housing market, where the standard deadweight loss of rationing apartments is accompanied by a further loss if apartments are not assigned to the agents with the highest valuations. In both cases, the gains from removing the distortion are amplified by eliminating the embedded institution. Our results also provide support for the idea that externally mandated changes in trade policy can ignite broader reform by enabling governments to overcome powerful domestic constituencies (Tang and Wei 2009).

The rest of the paper proceeds as follows. Section 2 briefly presents a model of quota allocation that is used to guide the empirical analysis. Section 3 offers a

⁴See Feenstra (1992) for a cogent summary of this research. For recent empirical studies of the MFA in particular, see Harrigan and Barrows (2009), Brambilla et al. (2010) and Bernhofen et al. (2011).

summary of the Multifiber Arrangement. Section 4 describes our data and Section 5 contains our empirical analysis. Section 7 explores alternative explanations for our findings. Section 6 describes our counter-factual analysis. Section 8 concludes.

2 Theory

This section outlines a simple model of exporting under quotas to guide our empirical analysis. It assumes that quotas are allocated to the most productive exporters via an auction. We emphasize two results. We show that while the removal of quotas can induce *less* productive firms to enter the export market, subsequent export growth and price declines are driven overwhelmingly by the *intensive* margin. In demonstrating these implications, we employ calibrated numerical solutions where analytic results cannot be obtained.

2.1 Exporting Under Quotas

We rely on a re-interpretation of Irarrazabal et al. (2010), which analyzes exporting by firms with heterogeneous productivity in a trading system where importing countries implement specific (i.e., per unit) as well as *ad valorem* tariffs. This model is a version of the well-known monopolistic competition, love-of-variety framework developed by Melitz (2003), which does not consider specific tariffs.⁵

We assume that in order to export a quota-bound good from origin country o to destination country d , firms must pay a license fee ($a_{od} > 0$) per unit exported as well as an *ad valorem* tariff ($\tau_{od} > 1$). As in Demidova et al. (2009) and Feenstra (2004), we interpret quota license fees as equivalent to per-unit increases in the cost of exporting.

Firm productivity φ is drawn from distribution $G(\varphi)$ with density $g(\varphi)$. The price of variety φ in export market d is given by

$$p_{od}(\varphi, a_{od}) = \frac{\sigma}{\sigma - 1} \omega_o \left(\frac{\tau_{od}}{\varphi} + a_{od} \right), \quad (1)$$

⁵Given the number of papers relying on the Melitz (2003) framework, we keep our discussion of the model in this section brief. We refer the reader to our appendix and Irarrazabal et al. (2010) for more details.

where $\sigma > 1$ is the constant elasticity of substitution across varieties and ω_o is the wage in the origin country. The existence of the final term in this expression differentiates it from its counterpart in Melitz (2003). It also provides a key intuition for our analysis: a positive license price exerts a disproportionately higher penalty on low-price (i.e., high-productivity) firms.⁶

The corresponding expression for export quantity is

$$q_{od}(\varphi, a_{od}) = p_{od}(\varphi, a_{od})^{-\sigma} (P_d)^{\sigma-1} Y_d, \quad (2)$$

where Y_d is expenditure in the destination market and P_d is a price index defined over domestic producers and origin-country exporters in the destination country. In Melitz (2003), the ratio of output produced by two firms with productivity $\varphi > \varphi'$ is independent of *ad valorem* trade costs. Here, this independence is broken by the addition of a specific tariff, with the result that reductions in the license fee induce relatively greater growth among low-priced firms.

We assume that the overall size of the origin-country export quota is determined exogenously via bilateral negotiations between the two countries. Given this quota, a Walrasian auctioneer determines the license price that induces firms to export the proper quantity, in aggregate. Intuitively, this license price will fall as the quota rises. This setup is similar to that of Anderson (1985), who demonstrates that the most efficient allocation of quotas implies a common license price.

Firms pay a fixed cost to enter the domestic market as well as the export market. A productivity cutoff, φ_{od}^* , determines the marginal exporter who is indifferent between paying the fixed costs of exporting from o to d , f_{od} , and remaining a purely domestic firm,

$$\varphi_{od}^* = \left[\left(\frac{\sigma - 1}{\sigma} \right) \sigma^{\frac{1}{1-\sigma}} \left(\frac{\omega_o f_{od}}{Y_d} \right)^{\frac{1}{1-\sigma}} \frac{P_d}{\omega_o \tau_{od}} - \frac{a_{od}}{\tau_{od}} \right]^{-1}, \quad (3)$$

where $P_d = P_d(\varphi_{od}^*)$. Here, too, the final term differentiates this expression from the cutoff equation in a standard Melitz (2003) model: in the presence of a quota, the productivity cutoff for exporting rises.

As discussed in Irarrazabal et al. (2010), there is no closed-form solution for

⁶In the data, firm prices may vary due to quality as well as efficiency. We discuss this issue in detail in Section 5.4.

P_d when the license price is positive. With P_d fixed (i.e., with country o too small to affect prices in country d), it is easy to verify that decreasing the quota reduces the productivity cutoff for exporting and thereby induces low-productivity firms in country o to enter the export market. This entry drags down country o 's unweighted average exporter productivity and raises its average export prices. With respect to the margins of adjustment, the overall market share of incumbent exporters declines but, *among* incumbent exporters, market share is reallocated towards the (largest and) lowest-priced firms.

More generally, P_d may rise or fall following quota removal depending upon the distribution of firm productivity. If the productivity of the most productive firms is sufficiently high, for example, export growth by the largest incumbents may offset the influence of entrants on quantity-weighted average productivity, or prevent entry altogether. Assessing the impact of quota relaxation when P_d is not fixed requires numerical solutions, which we pursue in the next subsection.

2.2 Numerical Solutions

The model summarized above can be solved numerically to determine how export prices and quantities as well as exporter productivity evolve as quotas are removed. We provide a brief description of these solutions here, but refer the interested reader to the appendix for further detail.

We consider two countries and one industry. The parameters of the model are: $\sigma, L = L_{Chn}, L_{UEC}, G(\varphi) \sim \ln \mathcal{N}(\mu, \theta), \tau = \{\tau_{Chn,Chn}, \tau_{Chn,UEC}, \tau_{UEC,Chn}, \tau_{UEC,UEC}\}, f = \{f_{Chn,Chn}, f_{Chn,UEC}, f_{UEC,Chn}, f_{UEC,UEC}\}, \omega = \{\omega_{Chn}, \omega_{UEC}\}$.⁷ We partition this set by imposing values for some parameters and choosing the remaining parameters by matching particular statistics in the data. We assume that the two countries have identical sizes $L_{UEC} = L_{Chn} = 100$.⁸ We choose an elasticity of substitution, $\sigma = 4$, that is the median among the apparel and textiles elastic-

⁷We set the domestic fixed costs $f_{Chn,Chn}$ and $f_{UEC,UEC}$ so that all firms are active in their respective domestic markets. This implies that we are choosing the ratio of the export to domestic fixed costs ($\frac{f_{Chn,UEC}}{f_{Chn,Chn}}$ and $\frac{f_{UEC,Chn}}{f_{UEC,UEC}}$) to match the fraction of textile and clothing exporters in each market. We assume iceberg trade costs are equal to 1 within countries, ($\tau_{Chn,Chn} = \tau_{UEC,UEC} = 1$).

⁸As discussed below, we consider the quotas imposed by the U.S., Canada and the E.U. (the "UEC"), whose total population (900 million) is relatively close to that of China (1.2 billion).

ities estimated in Broda et al. (2006). We assume a log normal productivity distribution, $G(\varphi) \sim \ln \mathcal{N}(\mu, \theta)$. We set the wage in each country equal to unity; although this assumption appears strong, it simply implies that the iceberg and fixed trade costs that we match to the data capture variation in wages as well as trade costs. We jointly choose the log normal mean and standard deviation, the two iceberg trade costs ($\tau_{Chn,UEC}$ and $\tau_{UEC,Chn}$) and the ratios of exporting to domestic fixed costs to match the following features of the data: the distribution of exports among Chinese textile and clothing exporters, the share of Chinese textile and clothing producers that export and the Chinese and U.S. market shares of U.S. and Chinese textile and clothing consumption in 2005, respectively.⁹ The resulting parameters are $\mu = 1.28$, $\theta = 0.54$, $\tau_{Chn,UEC} = 1.80$, $\tau_{UEC,Chn} = 3.55$, $f_{Chn,UEC}/f_{Chn,Chn} = 1.15$ and $f_{UEC,Chn}/f_{UEC,UEC} = 1.15$.

Using these parameters, we solve for the export productivity cutoffs ($\varphi_{Chn,UEC}^*$ and $\varphi_{UEC,Chn}^*$) and domestic price indexes (P_{UEC} and P_{Chn}) in each country in a no-quota equilibrium, i.e., where the license price is set to zero. We then re-solve the model for a positive, common license price that yields the the 2004 level of observed “quota restrictiveness”, which we define as 1 minus the ratio of exports under quotas to exports without quotas. In the data, the median growth of Chinese exports of quota-restricted goods relative to unrestricted goods was 155 percent in 2005 relative to 2004, implying a quota restrictiveness of 0.61 ($1 - 1/2.55$).¹⁰ We refer to this solution as the “auction allocation” of the quota licenses.

Table 1 compares numerical solutions of the model under the auction-allocation and no-quota scenarios. The first two rows of the table compare the price indexes

⁹China’s Annual Survey of Industry collected by the National Bureau of Statistics (NBS) reports that 44 percent of firms in the textile and clothing sectors (Chinese Industrial Classifications 17 and 18) exported in 2005. The share exports accounted for by the 75th, 90th, 95th, 99th and 99.9th percentiles of these exporters are 0.26, 0.46, 0.59, 0.80, 0.93 and 1, respectively. We were unable to obtain import penetration figures and fraction of textile exporters for Canada and the EU, so we use the US data to determine the trade cost parameters. According to textile and clothing production and trade data in the NBS production and Chinese customs data, respectively, the U.S. market share of Chinese textile and clothing (China Industrial Classification codes 17 and 18) consumption is 1.2 percent. According to the NBER Productivity Database, the Chinese market share of U.S. apparel and textile consumption (NAICS codes 313, 314 and 315) is 13.1 percent. All data are from 2005 because that is the first post-quota year.

¹⁰This 155 percent growth rate is relative to quota-unconstrained textile and clothing exports as well as to export growth of both types of exports in 2004, i.e., a “triple” difference that is explained in greater detail in Section 4.3. We assume this measure of quota restrictiveness is independent of whether quotas are allocated efficiently or inefficiently in 2004.

of the two countries. As expected, P_{UEC} declines with the removal of quotas, by 2 percent. This price decline is a function of the reallocation of exports to higher-productivity firms and the removal of the license fee. The entry of low-productivity firms is manifest in the decline of average productivity by 5 percent in row three, while the more-than-offsetting expansion of high-productivity firms is evident in the 24 percent increase of *weighted* average productivity in row four.¹¹ Similar movements occur in export prices in rows five through seven, where we find incumbents account for virtually all of the 29 percent decline in Chinese export prices following quota removal. The remaining rows of the table document the disproportionate growth of the highest-productivity incumbents: while the largest 25 percent of firms see their market share rise 17 percent, the market share of the top 1 percent of firms grows 82 percent. Despite the entry of new exporters, incumbents only lose 1 percent of their market share ($1 - 23.88/24.13$) when the quotas are removed. This small loss of overall incumbent market share is an important implication of the auction allocation; its empirical analogue serves as a key moment in our calibration of “political allocation” in Section 6.

3 A Brief Summary of the MFA

China’s textile and clothing industry accounts for a substantial share of its overall economy. In 2004, it employed 12.9 million workers, or 13 percent of total manufacturing employment (2004 China Economic Census). China’s textile and clothing exports account for 15 percent of the country’s overall exports, and 23 percent of world-wide textile and clothing exports (which equaled \$487 billion in 2005).

The Multifiber Arrangement (MFA) and its successor, the Agreement on Textile and Clothing (ATC), grew out of restraints imposed by the U.S. on imports from Japan during the 1950s. Over time, it evolved into a broader institution that regulated the exports of clothing and textile products from developing countries to the U.S., E.U., Canada, and Turkey. (We drop Turkey from the analysis because

¹¹As noted in Irarrazabal et al. (2010), the large gains associated with the removal of licensing fees exceed those implied by traditional trade models that solely consider the removal of iceberg transportation costs (e.g., the class of trade models discussed in Arkolakis et al. 2010). The size of the gain is also sensitive to the distribution from which productivity is drawn. As discussed further in footnote 30, if we follow the same procedure to solve the model using a Pareto distribution for firm productivity, we find a weighted-average productivity gain of 42 percent.

we are unable to locate the list of products covered by its quotas; in 2004, textile and clothing exports to Turkey accounted for less than 0.5% of China's total textile and clothing exports.) Bargaining over these restrictions was kept separate from multilateral trade negotiations until the conclusion of the Uruguay Round in 1995, when an agreement was struck to eliminate the quotas over four phases. At the beginning of 1995, 1998, 2002 and 2005, the U.S., E.U. and Canada were required to remove textile and clothing quotas representing 16, 17, 18 and the remaining 49 percent of their 1990 import volumes, respectively. The order in which goods were placed into a particular phase varied across importers, with each country generally choosing to place their most "sensitive" textile and clothing products into the final phase (Phase IV) to defer politically painful import competition as long as possible (Brambilla et al. 2010). This aspect of the liberalization suggests that the quotas were most binding at the final removal of quotas on January 1, 2005. However, the fact that Phase IV goods were determined in 1995 implies that their choice was not influenced by demand or supply conditions in 2005.¹²

China did not become eligible for quota removal until it joined the WTO at the end of 2001. In early 2002, its quotas on Phase I, II and III goods were relaxed immediately. Removal of quotas on Phase IV goods – the focus of our empirical work – occurred according to schedule on January 1, 2005.¹³

Like other countries under the MFA and ATC, China officially allocated quotas on the basis of past performance, i.e., firm's ability to export their quota successfully in the previous year (Krishna and Tam 1998). As documented in Moore (2002), however, China's actual allocation of quotas deviated from this principle, at times substantially. In the 1980s in particular, rent-seeking and political fa-

¹²The large increase in exports following quota removal in 2005 might be driven in part by firms' expectations that the MFA would be succeeded by another form of quantitative restrictions: by boosting exports, firms may have been hoping to receive a higher allocation under the new regime. In fact, the U.S. and E.U. did reimpose safeguard quotas on a subset of products in 2005. We have been unable to determine the products subject to safeguards in the E.U., but we find that our results are unchanged if we exclude products subject to safeguards in the U.S. market in 2005.

¹³The removal of quotas coincided with China's obligation under its WTO accession agreement to eliminate export licensing in all products by 2005. The products that were subject to state trading and designated traders are listed in Appendix 2A2 and 2B of China's WTO accession document (WT/ACC/CHN/49), respectively. In 2004, these products account for just 1 percent of total textile and clothing export value to the U.S., E.U. and Canada in 7 percent of the product codes. The results of our analysis are unchanged if we exclude these products from the analysis.

voritism were rampant. Firms managed by individuals affiliated with the People's Liberation Army, for example, received quotas in return for their support of the government, and these allocations were increased in 1989 following the army's backing of the state during the Tiananmen crisis. Likewise, there is evidence that the central Ministry of Commerce provided quota allocations to provincial authorities in an effort to promote textile and clothing manufacturing geographically (Ministry of Foreign Trade and Economic Cooperation 2001). Our analysis is unable to identify the precise objective function that the government sought to maximize, but by considering the deviation in the actual quota assignment from one that assigned quotas on the basis of firm productivity, our analysis quantifies the cost of pursuing an allocation of quotas based on alternative criteria.

Although trading quotas in China was illegal throughout the MFA, anecdotal evidence suggests that an active black market emerged during the 1980s. One consequence of the difficulties associated with firms' inability to trade quotas legally was unused quota. To prevent quota from going unused, the government stepped up enforcement of allocations based on past performance, and tried to prevent non-producing firms from receiving quotas (Moore 2002). These reforms are generally believed to have reduced black-market activity, though verification of this claim is difficult given firms' (understandable) reluctance to discuss illegal trading (Moore 2002; interviews conducted by the authors). The illegality of a secondary market is likely to have frustrated the resale of quotas, implying that quotas may not have found their way to agents who valued them the most. The potential sensitivity of our results to legal or illegal subcontracting, as well as empirical exercises designed to measure it, are discussed further in Section 7.

Starting in 2000, the government experimented with allowing some firms to participate in auctions of up to 30 percent of the total quota allocation of some MFA goods. Unfortunately, we have been unable to determine the precise criteria the government used to select firms to participate in these auctions.

4 Data

Our empirical analysis relies on data from several sources. The first is Chinese customs data by firm, eight-digit Harmonized System (HS) category and destination

country. For each firm-product-country observation, we observe the total nominal value and quantity exported as well as whether firms fall into one of three ownership categories: state-owned enterprises (“SOEs”), domestically owned private firms (“domestic”) and foreign-invested private firms (“foreign”).¹⁴ Quantity units are available for 99 percent of observations accounting for the same share of export value, and vary across products, e.g., dozens of shirts or square meters of fabric. We combine the nominal value and quantity data to construct nominal unit values, also referred to as “prices”.

We focus on China’s exports of textile and clothing products to the U.S., Canada and the E.U., treating the latter as a single block of countries given that quotas are set for the union as a whole. Product-country pairs are partitioned into two groups. The first, referred to as “MFA” product-country pairs, encompass textile and clothing products bound by quotas until 2004. The remaining product-country pairs, referred to as “OTC”, for “other textile and clothing” product-country pairs, consist of textile and clothing products exported quota-free.¹⁵ Because our classification refers to product-country pairs, it is possible for a given HS product to be both MFA and OTC depending upon its destination. For example, a textile and clothing product subject to a quota only in the U.S. *exported to the U.S.*, is MFA, but if it is *exported to the E.U.*, is OTC.¹⁶ Among the 547 products that are subject to quotas by any of the U.S., the E.U. or Canada, 157 are subject to quotas by all three destinations, while 167, 63, and 4 are subject to quotas solely in the U.S., solely in the E.U. and solely in Canada, respectively.

¹⁴We classify “state-owned” firms as SOEs; “collective-owned”, “other” and “private domestic” firms as domestic, and “foreign-exclusive owned” and two joint venture classifications as foreign.

¹⁵Textile and clothing products are defined as: two-digit HS chapters 50-63; four-digit HS chapter 6406; five-digit HS chapters 30059, 65059 and 94049; and six-digit HS chapter 701919. MFA products are a subset of these HS chapters and are defined according to a concordance made available by the Embassy of China’s Economic and Commercial Affairs office which identifies the set of products subject to quotas in each destination market in 2004. Note that some products in the OTC category were subject to quotas that were removed in 2002 under earlier phases of the quota liberalization. Comparisons of the trends noted in the text to goods outside of textiles and clothing, as well as textile and clothing exports to the rest of the world, appeared in an earlier version of this paper and are available upon request.

¹⁶A particular firm may appear in more than one group if it exports to multiple countries or if it exports more than HS category. We find that 86 percent of MFA firms in 2004 export at least one of their MFA HS categories to at least one quota-free country (e.g., Japan). These firms represent 77 percent of MFA export value in 2004. The comparable figure for OTC firms and OTC export value are 40 and 65 percent, respectively.

We assess the extent to which quotas were allocated to the most productive firms by examining changes in MFA exports before and after quotas were removed on January 1, 2005 using outcomes in OTC as well as prior years as controls. These comparisons capture broad trends affecting China’s textile and clothing exports during this period, such as improvements in productivity or privatization, and our ability to make use of them is a unique advantage of our analysis.

A more direct approach to identifying misallocation of quotas would be to compare the estimated TFP of firms assigned quotas in 2004 to those which export freely in 2005. In principle, this comparison could be accomplished by matching firms’ trading behavior in the customs data to information on their output and inputs recorded in China’s annual survey of manufacturing collected by the National Bureau of Statistics (NBS). In practice, matching these two datasets is difficult.¹⁷ Another alternative would be to use the indicator for firms’ export status in the NBS production data to determine their participation in quota-constrained export markets. Unfortunately, this indicator cannot be used to distinguish between MFA and OTC exports because it neither records the countries to which firms export nor the specific HS codes exported. The only industry information available in the NBS is a code for firms’ major line of business.

5 Reallocation Following Quota Removal

The model developed in Section 2 highlights three empirical implications of the removal of auction-allocated quotas: a reallocation of export market share towards the largest, most productive incumbents; a reduction in incumbents’ export prices due to the removal of license fees; and the entry of less-productive but higher-priced exporters. We find substantial differences between the data and the predictions of the auction-allocation model.

¹⁷Matching must be done using firm names rather than numerical identifiers. We have succeeded in matching 9,558 (31 percent) of the 2005 MFA and OTC exporters to the NBS production data. These exporters account for 35 percent of total MFA and OTC export value. By ownership type, we match 9 (6), 19 (30) and 58 (77) percent of SOE, domestic and foreign firms (value), respectively. We suspect that very low match rate for SOEs is due to their use of a trading division to export. As discussed further in Section 7.2, this suspicion is strengthened by relatively high prevalence of the phrase “trading company” in their names despite their being included in the NBS, which purportedly tracks producers.

5.1 Export Growth Following Quota Removal

Chinese export growth in 2005 is disproportionately large for textile and clothing goods released from quotas, and generally occurs at the expense of state-owned enterprises.

As indicated in the top panel of Table 2, MFA product-countries registered a 307 percent increase in export value between 2000 and 2005. By comparison, export growth is 205 percent for OTC and 236 percent for Chinese exports as a whole. MFA's differentially large growth is due primarily to the 119 percent jump in export value that occurs in 2005, the year that quotas are removed. Its annual growth in prior years, by contrast, averages just 17 percent.¹⁸

Data in the lower panel of Table 2 indicates that the surge in MFA export value in 2005 is accompanied by a 96 percent increase in the number of MFA exporters. Here, too, this jump is large relative to prior years as well as the 39 percent increases in OTC exporters over the same period. This relative growth in the number of exporters provides the first indication of the potential importance of the extensive margin in MFA's response to quota removal. We also find that MFA export growth is uneven across ownership types: SOEs account for 54 percent of MFA in 2004 versus 44 percent for OTC. Once quotas are removed, Table 3 shows that this gap falls markedly: in 2005, SOEs' market share is 38 percent in MFA and 36 percent in OTC. Together, these facts highlight three trends about MFA exports following quota removal. First, MFA export growth is relatively high compared to previous years and to OTC, indicating that MFA quotas were binding. Second, growth in MFA export value is accompanied by a similarly large increase in the number of MFA exporters, which suggests a prominent role for the extensive margin. Finally, the reallocation of market share away from publicly owned SOEs and towards privately owned domestic and foreign firms suggests that SOEs may have received an excessive level of quota under the MFA.

The transfer of MFA market share between ownership types can be used to compute a coarse, back-of-envelope estimate of the productivity gain associated with the replacement of SOEs by privately owned firms. Using the NBS produc-

¹⁸U.S., E.U. and Canadian quotas on China's MFA export quantities grew an average of 2 to 3 percent per year once China was admitted to the WTO in December 2001 (Brambilla et al. 2010). The relatively high value growth displayed before 2004 in Table 2 reflects a combination of this growth in quantity as well as sizable increases in prices.

tion data we compute the relative productivity of exporters by firm ownership type, restricting our comparison to exporters in 2005 whose major line of business is textiles or clothing (industry codes 17 or 18). Figure 1 plots the resulting distributions of textile and clothing exporters' TFP relative to the hypothetical average textile and clothing firm by type of ownership.¹⁹ SOE exporters' distribution lies clearly to the left of the distributions of privately owned exporters. The first column of Table 4 reports each ownership type's TFP relative to the hypothetical mean from Figure 1. On average, SOEs are 18 percent less productive than the hypothetical mean exporter, while privately owned domestic and foreign exporters are 88 and 72 percent more productive. These estimates are consistent with broader measures of TFP differences among state- and privately owned firms found by Brandt and Zhu (2010) and Hsieh and Klenow (2009). The second column reports the relative changes in each ownership type's market share between 2004 and 2005. Multiplying through, we find that the reallocation of market shares observed in 2005 implies an increase in exporters' TFP of 13.5 percent. This estimate relies on the strong assumption that firm productivity is constant within ownership types, which is at odds with Figure 1 and additional evidence on export prices presented below. Below, we derive an alternate estimate of aggregate productivity growth associated with quota removal that relaxes this assumption.

5.2 Margins of Adjustment

We find that export growth following quota removal favors privately owned entrants primarily at the expense of incumbent SOEs.

Export growth can be decomposed into one intensive and two extensive margins. The intensive margin is populated by incumbents, by which we mean eight-digit HS products exported by the same firm to the same country in both 2004 and 2005. The extensive margin is comprised of entrants and exiters. Entrants

¹⁹We follow Brandt et al. (2009) in estimating firm f 's TFP using a Törnqvist index number approach, $\ln(TFP_f) = (va_f - \overline{va}) - \tilde{s}_f(w_f - \overline{w}) - (1 - \tilde{s}_f)(k_f - \overline{k})$, where va_f , w_f , and k_f are in logs and denote firm value added, wages and fixed assets (net of depreciation), $\tilde{s}_f = (s_f + \overline{s})/2$, s_f is the share of wages in total value added, and where a bar over a variable denotes an average across all textile and clothing exporters. TFP for each firm is relative to a hypothetical firm with the average output and inputs. Wages are defined as reported firm wages plus employee benefits (unemployment insurance, housing subsidies, pension and medical insurance), and capital is defined as reported capital stock at original purchase price less accumulated depreciation.

are firm-product-country triplets which appear in 2005 but which were not present in 2004. Exiters exhibit the opposite pattern. Given these definitions, multiple-product exporters may be counted in more than one margin of adjustment, e.g., they may exit one product-country and enter another.

We examine reallocation in terms of quantity- rather than value-based market share due to the large price changes documented in the next section. Under the auction-allocation scenario presented in Section 2, export growth following quota removal should be concentrated among the largest incumbents due to their (presumed) greater productivity. Instead, we find the opposite. Figure 2 plots the locally weighted least squares relationship between incumbents market share within their product-country pair in 2004 and their change in this market share between 2004 and 2005. Separate relationships are plotted for each ownership type, by group. The negative relationships across ownership-group pairs likely reflects mean reversion. However, this decline is more pronounced in MFA than OTC, and most severe for SOEs within MFA. This result provides further indication that SOEs received excessive allocations under quotas.²⁰

A formal decomposition of 2004 to 2005 MFA quantity market share reallocation by margin of adjustment is presented in the first panel of Table 5. It is constructed by determining the quantity market share of each margin (m) within each product-country pair (hc) in each year, $\Theta_{mhct} = \left(\frac{\sum_{f \in m} q_{fhct}}{\sum_m \sum_f q_{fhct}} \right)$, taking the difference between years and then averaging these differences across the product-country pairs. Differences are in bold if they are statistically significantly different from zero at the 10 percent level.

The left panel of Table 5 summarizes the “single-difference” shift in market share from incumbents to net entrants within MFA from 2004 to 2005 as quotas are removed. Entrants are decomposed into “new exporters”, which are firms that did not export at all in 2004, and “adders”, which are firms that exported one or more other (potentially MFA) products in 2004 prior to adding an MFA product in 2005.²¹ Incumbents’ market shares decline by an average of 21 percentage points

²⁰We note that the strong role of the extensive margin might be explained by capacity constraints among incumbents as quotas are removed. While this explanation is plausible, it seems unlikely given that the dates of quota removal were known ten years in advance, providing incumbents with ample time to prepare.

²¹A given firm may contribute to both the intensive and “adder” extensive margins if it both

across product-destination pairs in the year quotas are removed. This decline is (necessarily) offset by a 21 percentage-point average gain by net entrants, for an overall average change of zero. Of this 21 percentage-point gain, adders and new exporters contribute 65 and 6 percent, respectively, while exiters account for -50 percent.

The remaining columns of the left panel of Table 5 decompose the overall “single-difference” change in MFA market share for each margin by type of firm ownership. Each row sums to the value in the first column of the panel. Two trends stand out. First, there is substantial *gross* reallocation of market share within each ownership type. This gross reallocation emphasizes firm heterogeneity within each type of ownership and is most pronounced among SOEs, where the relatively high 32 percent market share lost by exiters is offset by a 26 percent market share gain by adders. Second, there is a *net* 21.9 percent reallocation of market share from SOEs to privately owned domestic (13.4 percent) and foreign (8.5 percent) entrants.²² Together, these gross and net reallocations suggest that the “excessive” quota enjoyed by some state-owned enterprises in 2004 came at the expense of both other SOEs as well as privately owned firms.

The “single” differences reported in the left panel of Table 5 do not reveal the extent to which 2004 to 2005 changes in MFA margins’ market shares deviate either from changes in OTC over the same period, or from these groups’ changes in the prior period. Such “triple” differences control for factors common to Chinese textile and clothing products over time such as the removal of entry barriers and the broad-based decline of SOEs. Triple differences are estimated via the following product-country level OLS regression:

$$\begin{aligned} \Delta\Theta_{mhct} &= \alpha_0 + \alpha_1 1\{t=2005\} + \alpha_2 1\{hc \in \text{MFA}\} \\ &+ \alpha_3 1\{t=2005\} \times 1\{hc \in \text{MFA}\} + e_{mhct}, \end{aligned} \quad (4)$$

where $1\{t=2005\}$ and $1\{hc \in \text{MFA}\}$ are indicators for 2005 and the presence of a continues exporting at least one MFA product between 2004 and 2005 and adds another MFA product during that interval. For more detail, see the appendix.

²²Price changes explain the difference between the 21 percent decline in SOEs average quantity-based market shares in Table 5 and their 16 percent decline in value-based market share in Table 3.

product-country pair in group MFA, respectively. The sum of all four coefficients equals the “single” differences reported in the left panel of Table 5. By itself, α_3 represents the triple differences reported in the right panel of Table 5. Complete regression results are reported in Table 10 of the appendix.

Triple differences convey the same basic message as the single differences, i.e., a strong reallocation of market share away from incumbent SOEs and towards privately owned entrants. This reallocation is inconsistent with quota removal under the auction model developed in Section 2 as well as the relatively high apparent productivity of entrants discussed below.²³

5.3 Prices

MFA export prices fall substantially when quotas are removed, largely due to net entry.

We compute the change in groups’ export prices in two steps. First, for each product-country (hc) pair in each year (t), we calculate a weighted-average export price (\bar{P}_{hct}) across all firms’ log export unit values, $\ln(p_{fhct})$, using their quantity market shares (θ_{fhct}) as weights²⁴,

$$\bar{P}_{hct} = \sum_f \theta_{fhct} \ln(p_{fhct}). \quad (5)$$

Then, for each product-country pair, we compute the change in this log price between years,

$$\Delta \bar{P}_{hct} = (\bar{P}_{hct} - \bar{P}_{hct-1}). \quad (6)$$

Each bar in Figure 3 displays the mean of $\Delta \bar{P}_{hct}$ across all product-country pairs in

²³In unreported results (available upon request), we find even stronger reallocation from SOE incumbents to privately owned entrants among product-country pairs where quotas are binding, i.e., where fill rates exceed 90 percent. Data on U.S., E.U. and Canadian fill rates are obtained from OTEXA, Système Intégré de Gestion de Licenses, and Foreign Affairs and International Trade Canada, respectively. We also find virtually identical triple-difference results after including product and country fixed effects, which control for trends in prices and identify changes within these groups between 2003 to 2004 and 2004 to 2005.

²⁴We use log prices to minimize the influence of outliers and to facilitate decomposition of observed prices into quality-adjusted prices below. Results are qualitatively similar if we drop outliers, i.e., product-country groups with the highest and lowest 1 percent of price changes.

MFA and OTC for 2004 and 2005. As indicated in the figure, MFA export prices on average fall by 0.179 log points, while OTC exports on average rise by 0.065 log points. The MFA decline is also sharp relative to the group’s average price growth of 0.01 log points in 2004.

Variation in normalized log export prices among MFA incumbents, entrants and exiters is displayed visually in Figure 4, which plots incumbents’ and entrants’ normalized 2005 log export prices and exiters’ normalized 2004 log export prices. In both cases the normalization involves subtracting off the across-year log mean price for product-country hc :

$$\bar{P}_{hc} = \frac{1}{2} (\bar{P}_{hct} + \bar{P}_{hct-1}). \quad (7)$$

Firms whose relative prices are below and above the first and ninety-ninth percentiles of each distribution, respectively, are removed from the figure to increase readability.

The ordering of the price distributions, with entrants to the left and exiters to the right, indicates that firms exiting MFA in 2004 have relatively high prices compared to 2005 entrants. On average, entrants’ prices are 0.25 and 0.21 log points lower than incumbents’ and exiters’ prices, respectively. By comparison, the top and bottom panels of Figure 5 reveal that we do not find a similar ordering of entrants’ and exiters’ prices either contemporaneously in OTC or in MFA the year before. A second notable feature of Figure 4 is MFA incumbents’ relatively thin left tail. This paucity of very low prices provides intuition for the loss of market share by incumbents discussed in the previous section. Indeed, incumbents’ ability to retain as much market share as they did given their relatively high prices may be due to market or policy asymmetries such as long-term contracts or better marketing information that give high-priced incumbents an advantage over low-priced entrants.

We quantify the relative importance of each margin in MFA price changes using a technique for productivity decomposition proposed by Griliches and Regev (1995):

$$\begin{aligned}
\Delta \bar{P}_{hct} = & \frac{1}{\bar{P}_{hct-1}} \left[\sum_{f \in I} \bar{\theta}_{fhc} (\ln(p_{fhct}) - \ln(p_{fhct-1})) + \sum_{f \in I} (\theta_{fhct} - \theta_{fhct-1}) (\bar{p}_{fhc} - \bar{P}_{hc}) \right] \\
& (8) \\
& + \frac{1}{\bar{P}_{hct-1}} \left[\sum_{f \in N} \theta_{fhct} (\ln(p_{fhct}) - \bar{P}_{hc}) \right] - \frac{1}{\bar{P}_{hct-1}} \left[\sum_{f \in X} \theta_{fhct-1} (\ln(p_{fhct-1}) - \bar{P}_{hc}) \right].
\end{aligned}$$

As above, θ represents quantity-based market share and f , h and c index exporters, eight-digit HS categories and countries, respectively. I , N and X correspond to the sets of incumbent, entering (new exporters plus adders) and exiting firms, respectively. (We forgo breaking entrants into adders versus new exporters given the relatively small market share of the latter in Table 5.) $\bar{\theta}_{fhc}$ is the average market share of firm f in hc across years, i.e., $\bar{\theta}_{fhc} = (\bar{\theta}_{fhct} + \bar{\theta}_{fhct-1})/2$. Finally, $\bar{p}_{fhc} = \frac{1}{2} (\ln p_{fhct} + \ln p_{fhct-1})/2$ is the across-year average price of firm f in product-country hc . Like $\bar{\theta}_{fhc}$, it can be computed only for incumbents.

The first term in square brackets captures the intensive margin. Its first, “within” component measures the price change of incumbent exporters holding their market share fixed. Its second, “across” component accounts for changes in incumbents’ market shares, weighting those changes by the difference between a firm’s average across-year price and the overall average across-year price. If incumbents’ prices fall with the quota fee, the within component is negative. If incumbents’ prices are relatively high and their market shares tend to decline, the across component is also negative and both components contribute to a reduction in $\Delta \bar{P}_{hct}$.

The second term in square brackets in equation (8) captures the entry margin; this term is negative if entrants’ prices are lower than the across-year average price. The third term in square brackets captures the exit margin. Its interpretation is analogous to the entry term, as it is positive if exiters have relatively high prices compared to the across-year average. Note that because the exit margin is *subtracted* from the previous two margins, positive values make a negative contribution to the overall price change.

We use regressions analogous to equation (4) to estimate single- and triple-

difference price decompositions. Complete regression results are reported in Table 11 of our appendix and are summarized in the two panels of Table 6 using the same format as with market shares above. Here, triple differencing controls for inflation (our value data are nominal) as well as other factors such as changes in technology and exchange rates that affect the prices of all Chinese textile and clothing export prices equally.

As results for single and triple differences are quite similar, we discuss the latter. We find that incumbents are responsible for just over one-third (37 percent) of the average 0.179 relative log point decline in MFA export prices in 2005. The within and across components of this adjustment reveal that most of this drop is due to loss of market share by relatively high-priced incumbents (-0.042) versus price declines (-0.025), but that both are sizable. The extensive margin accounts for the remaining 63 percent of the overall price decline, with entrants' relatively low prices and exiters' relatively high prices contributing 39 and 24 percent on average, respectively.

More so than with market share changes, price changes are the result of both gross and net reallocations within and across ownership types. Price declines and loss of market share by incumbent SOEs account for one-fourth over the overall drop in prices (-0.052/-0.179). Net entry by SOEs not favored by quota allocation in 2004 contributes another fourth (-0.51/-0.179), with entry and exit contributing roughly equal amounts. Finally, entry by low-priced privately owned firms contributes another third (-0.062/-0.179). To the extent that low prices reflect high productivity, these trends are inconsistent with allocation of quotas to the most productive firms under the MFA.

5.4 Quality, Quality-Adjusted Prices and Productivity

Long-standing research on quotas discusses firms' incentives to increase product quality when quotas are imposed and decrease it when they are removed (Aw and Roberts 1986, Feenstra 1988 and Boorstein and Feenstra 1991). This incentive comes from the relatively high penalty quotas exert on low-price – here interpreted as low-quality – goods. From a quality perspective, the relative price declines documented above may reflect quality downgrading by incumbents and the entry and exit of low- and high-quality textile and clothing varieties, respectively.

We estimate export “quality” (λ_{fhct}) by embedding preference for it in the CES utility function used above: $U = \left(\int_{\omega \in \Omega} (\lambda(\omega)q(\omega))^{(\sigma-1)/\sigma} d\omega \right)^{\sigma/(\sigma-1)}$. With these preferences, demand for a particular firm’s export in destination country c is given by:

$$q_{fhct} = \lambda_{fhct}^{\sigma-1} p_{fhct}^{-\sigma} P_{ct}^{\sigma-1} Y_{ct}. \quad (9)$$

Taking logs and using the elasticity of substitution $\sigma = 4$ from Section 2.2, we use the residual from the following OLS regression to infer quality:

$$\ln q_{fhct} + 4 \ln p_{fhct} = \alpha_h + \alpha_{ct} + \epsilon_{fcht}, \quad (10)$$

where $\hat{\lambda}_{fcdt} \equiv \hat{\epsilon}_{fcht}/(\sigma - 1)$. The intuition behind this approach is straightforward: conditional on price, a variety with a higher quantity is assigned higher quality.²⁵ By imposing the same elasticity of substitution across textile and clothing products, we avoid having to estimate demand before inferring quality. In our estimation, α_{ct} collects both the destination price index (P_{ct}) and income (Y_{ct}). The product fixed effect α_h is included because prices and quantities are not necessarily comparable across product categories. The quality-adjusted price is the observed log price less estimated quality, which is already in logs.

Table 7 decomposes MFA quality changes by margin of adjustment and ownership type using the same format as previous decompositions. The single-difference results in the left panel indicates an average increase in overall MFA quality across hc pairs of 0.044 log points. Consistent with the quota literature, however, the triple-difference results in the right panel indicate an average decline in relative MFA quality of -0.109 log points. SOE and privately owned domestic firms are

²⁵See Hummels and Klenow (2005), Khandelwal (2010), Hallak and Schott (2011) and Feenstra and Romalis (2011). We infer quality from the demand side and do not specify a model that accounts for firm quality choice (e.g., Kugler and Verhoogen (forthcoming) and Johnson (2010)). Here, quality is defined very broadly: it is anything that raises consumer demand for a product other than price. This method for inferring quality downgrading within products, also used by Broda and Weinstein (2010), differs from the across-product approach adopted by Harrigan and Barrows (2009) and developed by Aw and Roberts (1986) and Boorstein and Feenstra (1991). In their approach, quality downgrading is defined as a shift in consumption from high- to low-priced HS categories over time, as identified by a relative decrease in a quantity-weighted versus value-weighted average price index. We follow our approach to identify quality changes because across-product evidence of quality downgrading does not account for quality changes within HS categories or within firms, which our data can address directly.

the major source of this decline: they account for half of the overall drop (-0.052/-0.109) and their contribution is statistically significant. While the results in the remaining cells of the table are consistent with low-quality entrants replacing high-quality exiters, they are not statistically significant except for the combined net entry of privately owned domestic firms, which accounts for another third of the overall decline (-0.032/-0.109).

Subtracting the decomposition in Table 7 from the decomposition in Table 6 yields the decomposition of quality-adjusted prices reported in Table 8. The triple differences in the right panel of the table reveal that MFA prices continue to exhibit a statistically significant relative price decline of -0.070 log points even after adjusting for quality. Likewise, net entry by low-price firms of each ownership type continues to account for a substantial and (jointly) statistically significant portion (-0.055/-0.070) of this overall decline. In fact, the extensive margin's contribution to the decline in quality-adjusted price changes (79 percent) is even higher than its contribution to observed price changes (63 percent; Table 6).

As indicated in the pricing rule from Section 2.2 (equation 1), changes in inverted quality-adjusted prices provide information about changes in firm productivity. Assuming the Chinese government awarded quotas without charging a fee from recipients (i.e., $a_{China,US} = 0$), the quality-adjusted price changes reported in Table 6 indicate that quota removal coincides with an average 0.070 log point increase in productivity across *hc* pairs.²⁶ While this productivity growth is consistent with the auction-allocation scenario in Section 2.2, entrants' contribution to it starkly violates the implication that new exporters be of lower productivity than incumbents. More than half of the total gain in productivity is due to entry (0.039/0.070), with SOEs and privately owned domestic firms contributing most of it. This estimated 0.070 log point gain in productivity is large relative to other estimates in the literature.²⁷ Brandt and Zhu (2010), for example, estimate average annual TFP growth of 4 percent for non-agricultural industries over 1998 to 2007.

The growth in productivity revealed by changes in quality adjusted prices represents the total gain from quota removal. In the next section we make use of

²⁶Since the price changes are in logs, multiplying through by -1 yields productivity.

²⁷We find an increase in aggregate productivity of 0.069 log points if we weight *hc* pairs by export value.

numerical solutions of the model to decompose this overall gain into the part due to misallocation versus the part accounted for by the removal of the quota.

6 Decomposing Productivity Gains

The empirical analysis in Section 5 demonstrates that the Chinese government did not allocate export quotas according to firm efficiency. To determine the drag on exporter productivity induced by this misallocation, we need to compare the actual allocation mechanism used by the government to the (counterfactual) auction-allocation mechanism. We approximate the government’s process for allocating quota licenses via a simple “political-allocation” scenario designed to match fundamental features of the data. We then compare the weighted-average productivity of exporters under this scenario to the weighted-average productivities found for both the auction-allocation and no-quotas models in Section 2.2.

The political-allocation scenario is constructed to match three key outcomes in the data following the removal of quotas in 2005: the growth in MFA export volumes, the growth in the number of MFA exporters, and the decline in incumbent market share. We fit the first two of these trends exactly and use the third to pin down the extent of the government’s misallocation under political allocation.

We assume that the aggregate quota imposed on China is the same under auction and political allocation, and therefore use the same quota restrictiveness (0.61) employed in Section 2.2. We choose the number of exporters that receive quotas under political allocation, N^{PA} , to match the 65 percent relative growth in MFA exporters observed in 2005 (Table 2),

$$\frac{N^{NQ} - N^{PA}}{N^{PA}} = 1.65, \tag{11}$$

where N^{NQ} is the number of exporters found in the no-quota scenario in Section 2.2.

In Section 5 we found that the decline in incumbent market share between 2004 and 2005 is key evidence in favor of misallocation. As a result, we need the political allocation scenario to assign quotas to enough low-productivity firms so that their dropping out of the export market once quotas are removed matches the

data. Toward that end, we assume that export shares are allocated on the basis of a second random firm draw, κ , that has rank correlation ρ with the productivity draw, φ , they received in the auction-allocation model in Section 2.2.²⁸ We interpret this second source of firm heterogeneity as a measure of firms' ability to obtain quota from the government, perhaps due to political connections. As with productivity, we assume that firms are "endowed" with their political connection and ignore any deadweight loss associated with potentially unproductive bribery or lobbying to obtain their political connection (Bhagwati 1982). For a given ρ , we sort firms according to κ and assign the 2004 export shares observed in the data to the top N^{PA} of these firms, from high to low.²⁹

Exporters' weighted-average productivity under political allocation is governed by ρ . Indeed, the magnitude of ρ is an indication of misallocation: the further its distance from 1, the less the resulting allocation is based on φ . We choose ρ so that the change in incumbents' market share between the political-allocation and no-quota scenarios matches the observed 16.7 percent relative decline in MFA incumbents' market share in 2005 (Table 5, right panel).

This match occurs at $\rho = 0.67$, implying a political-allocation weighted-average productivity of 3.26. This productivity is lower than the weighted-average productivities of 3.43 and 4.21 found for the auction-allocation and no-quota models, respectively (Table 1), for two reasons. First, some low productivity firms that do not get quotas under auction allocation receive them under political allocation because they have a high κ (i.e., high political connections). Second, the export market shares of some high-productivity firms under political allocation are lower than they would be under auction allocation because they have a low κ .

Our results indicate that 18 percent $((3.43-3.26)/(4.21-3.26))$ of the gain from removing quotas is due to the removal of misallocation (e.g., replacement of political allocation with auction allocation), while 82 percent is due to the direct removal of the quota (movement from auction allocation to no quota).³⁰ If we

²⁸ $\kappa = \rho\varphi + \sqrt{(1-\rho^2)}\epsilon$: ϵ is a standard normal and ρ is the correlation between φ and κ .

²⁹Because there are more firms in the model than the data, we group the N^{PA} firms in the model evenly into bins so that the number of bins in the model equals the number of firms in the data. The group of firms with the highest κ receive the highest market share, the group with the next highest κ receives the second highest market share, and so forth. The empirical market share assigned to each bin in the model is divided evenly across its constituent firms.

³⁰Similar results are obtained using a Pareto distribution for firm productivity, in which case

apply this decomposition to the productivity calculation in Table 8, it implies that the removal of the actual licensing institution increased exporters' productivity by 1.3 percentage points (0.07×0.18). Put differently, we find that removing misallocation increases exporter productivity an additional 28 percent $((4.21-3.26)/3.26$ vs $(4.21-3.43)/3.43$) versus auction allocation.

This effect of misallocation can be placed in context by noting that Hsieh and Klenow (2009) calculate TFP gains of 23 to 30 percent from removing *all* domestic distortions from Chinese manufacturing in 2005. Our analysis indicates removal of China's textile and clothing quota licensing regime by itself would increase TFP among exporters by 5.2 percent ($3.43/3.26$). Given the myriad other distortions that likely exist in Chinese manufacturing, our estimate seems plausible.

7 Subcontracting

7.1 Subcontracting by Producing Firms

Our estimates are sensitive to unobserved subcontracting. More precisely, if the quota-holding firm and the ultimate producer of the export are different, and if customs documents list the name of the former rather than the latter, then our estimates of extensive-margin activity following quota removal will be biased upwards if subcontractors officially replace quota holders on trade documents starting in 2005. Furthermore, assignment of subcontracts on the basis of efficiency (for example, via a black-market auction) would complicate our ability to identify a reallocation of exports towards more efficient firms when the MFA ended.

In principle, subcontracting's influence on our results should be minimal given its illegality. Unfortunately, as noted in Section 3, we have been unable to determine via interviews or secondary sources the extent to which it might have occurred. Nevertheless, five trends in the data suggest that subcontracting exerts a limited effect on our results.

we find a shape parameter of 4.5, $\tau_{Chn,US} = 1.7$, $\tau_{US,Chn} = 3.05$, $f_{Chn,US}/f_{Chn,Chn} = 1.75$, $f_{US,Chn}/f_{US,US} = 1.05$ and rank correlation $\rho = 0.70$. Given these parameters, weighted-average productivity under political allocation, auction allocation and no quotas is 2.36, 2.54, and 3.61, implying that 14 percent of the gain from removing quotas is due to the elimination of misallocation.

First, if quota holders were subcontracting to efficient non-quota holders, one might expect these subcontractors to be dominated by a relatively small number of large (i.e., efficient) producers, and that these producers would dominate entry once quotas are removed. Instead, as noted in footnote 21 in Section 5.2, we find that *new* MFA entrants in 2005 are relatively numerous and relatively small.

Second, if subcontracting were the only way a firm with a quota could fulfill it, the firms relying on subcontractors in 2004 would exit or shrink substantially once quotas were removed. In fact, we find that few incumbents' exports actually decline from 2004 to 2005, and that MFA exit rates are relatively low compared with OTC exit rates across all ownership types (Table 5).³¹

Third, we find that 86 percent of the quota-holding MFA exporters in 2004 are also active in similar products destined for other markets. Given that these firms are present in these other markets, they likely have the ability to produce for MFA as well. (Subcontracting exports of textile and apparel goods to other markets makes little sense given that they were not constrained by quotas). It is therefore not obvious why a quota-holder would subcontract production of MFA but produce its own output of similar products for exports to other destinations.³²

Fourth, we find little evidence in the NBS production data that textile and clothing producers' exports exceeded their production, as might be expected if they were on-exporting subcontractors' output. In both 2004 and 2005, the production-to-export ratio is greater than one for 95 percent of firms that report textile and apparel as their main line of business. One caveat here is that information revealed by the production-to-exports ratio depends on the relative importance of the export market; firms selling large quantities domestically might nevertheless export a relatively small amount of subcontracted production.

Finally, we find a relatively strong contribution by the extensive margin in "processing" versus "ordinary" exports, where the former refers to exports that are assembled in an export processing zone with a disproportionate share of raw materials that are imported at reduced or often zero tariff rates. Subcontracting

³¹While it is true that SOEs' market shares decline substantially, this reallocation is driven by faster growth among privately owned firms than SOEs, i.e., almost all incumbents experienced growth in export quantity between 2004 and 2005.

³²As discussed in Section 3, virtually all MFA products had full trading rights so all firms could directly export an MFA product to the rest of the world if they so chose.

of processed exports is more difficult, especially for subcontractors that lie outside the processing zone, given that the rules governing this class of exports must be obeyed by the subcontractor.³³ Table 9 compares the relative contribution of the extensive margin in MFA versus OTC exports for processed versus all exports. We find that MFA incumbents lose *more* relative market share in processing exports (-21.7 percent) than in all exports (-16.7 percent), and a similar reallocation away from SOEs.

7.2 Subcontracting by Intermediaries

Unobserved subcontracting by intermediaries (i.e., non-producing “trading” firms) presents a different challenge to identification than subcontracting by producers: while the latter had no reason to continue once the quota institution ended, there is no reason for the former to disappear. Furthermore, even if the number of intermediaries remained constant between 2004 and 2005, the number of producing firms with which they contracted – and, therefore, their influence on the “true” adjustment of China’s extensive and intensive margins – would be unknown because we do not observe the set of producers from which an intermediary sources.

One might expect trading firms to be replaced by producers in 2005 if quota-rich trading firms were an important conduit for quota-poor producers’ goods. In fact, we find relatively strong entry by “trading firms”, defined as in Ahn et al. (2011) as firms with the words “importer”, “exporter” or “trader” in their title, in MFA versus OTC between 2004 and 2005. One reason for this growth that is consistent with our conclusions above but which contributes to an *under-estimation* of the influence of the extensive margin, is that intermediaries helped a new set of low-productivity entrants overcome the fixed costs of exporting once quotas were removed (Ahn et al. 2011). One caveat associated with this conclusion is that our classification of firms as trading companies is imperfect, and, in particular, might result in firms that have both production and trading arms being classified as traders. A large fraction of the textile and clothing apparel SOEs that export, for example, are classified as traders, which is at odds with the evidence presented above that virtually all SOEs in the NBS production data have higher production

³³We identify processed exports via a flag in the customs data. Processed exports account for 19 and 20 percent of MFA exports in 2004 and 2005, respectively.

output than exports. Indeed, according to our classification, trading companies account for 48 and 46 percent of OTC and MFA exports in 2004, which is quite large relative to the 24 percent share of intermediaries in China’s overall exports. We suspect that state-owned manufacturers may export through trading arms of their production facilities under a name that contains the phrases “importer”, “exporter” or “trader”. This may be why we are only able to match 9 percent of state-owned textile and clothing exporters in the customs and production data by name even though the production data contains a census of SOEs.

Given our concern of classifying these state-owned clothing and apparel exporters as intermediaries, we investigate the effects of treating all SOEs as producers. We find that as a result of this reclassification, the export share of the remaining firms classified as traders falls to 13 and 11 percent, respectively. This result suggests that although intermediaries help facilitate trade in this industry, their role is relatively small, perhaps because the U.S., E.U. and Canada are relatively large markets which makes direct exports profitable.

8 Conclusion

We evaluate the productivity gains associated with a specific trade liberalization, the removal of quotas on Chinese textile and clothing exports to the U.S., E.U. and Canada in 2005. We find that quota removal coincides with substantial reallocation of export activity from incumbents to entrants, and show that this reallocation is inconsistent with an *ex ante* assignment of quotas by the Chinese government on the basis of firm productivity. As a result, we find that the standard productivity growth expected from the removal of this trade barrier is magnified by the concomitant elimination of the institutions that grew up around it. Our counterfactual analysis suggests that productivity growth from quota removal is 27 percent higher than it would be if quotas had been allocated according to firm efficiency.

Our analysis provides intuition for why empirical findings of the productivity gains from trade (e.g., Feyrer 2009 and Pavcnik 2002) are often large compared to the relatively modest gains predicted by many trade models (Arkolakis et al. 2010). While theoretical models typically presume an efficient allocation of resources, conditional on trade barriers, institutions that evolve to manage them are subject

to corruption or capture, imposing additional distortions. Because reforming these institutions can be politically difficult, externally mandated reforms that dismantle them can deliver outsized gains.

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Tables

Table 1: Comparison of Outcomes Under the “No-Quota” and “Auction-Allocation” Scenarios

Outcome	Auction Allocation (1)	No Quota (2)	Ratio (3) = (2)/(1)
Price Indexes			
$P_{\text{chn}} \times 10^2$	0.78	0.78	1.00
$P_{\text{US}} \times 10^2$	0.76	0.74	0.98
Productivity of Chinese Exporters			
Unweighted Average	2.14	2.03	0.95
Weighted Average	3.43	4.21	1.24
Chinese Export Prices			
Unweighted Average (All)	1.40	1.29	0.92
Weighted Average (All)	1.02	0.73	0.71
Weighted Average (Incumbents)	1.02	0.71	0.70
Chinese Export Quantity to U.S.			
All	9.41	24.13	2.56
Incumbents	9.41	23.80	2.53
Market Share of Largest Chinese Exporters			
Top 25%	0.58	0.68	1.17
Top 10%	0.36	0.48	1.32
Top 5%	0.24	0.35	1.45
Top 1%	0.09	0.16	1.82
License Price	0.14	na	na

Notes: Table summarizes the "no-quota" and "auction allocation" solutions to the calibrated model presented in Section 2.1. Weighted averages are across firms using export quantities as weights. The final column is second column divided by first column.

Table 2: Export Value and Number of Exporters to the U.S., E.U. and Canada, by Product

	Export Value (\$Billion)		
	OTC	MFA	Total
2000	6.2	4.8	231.4
2001	6.6	6.2	285.8
2002	7.9	6.5	325.6
2003	11.2	7.9	438.5
2004	14.3	8.9	593.6
2005	18.8	19.6	776.6
%Growth 2000-5	205	307	236
Annual %Growth 2000-4	23	17	27
%Growth 2004-5	32	119	31

	Number of Exporting Firms		
	OTC	MFA	Total
2000	5,298	3,536	47,413
2001	6,482	4,253	59,527
2002	9,652	5,911	78,612
2003	12,701	7,793	95,688
2004	16,554	9,523	120,535
2005	23,001	18,628	143,676
%Growth 2000-5	334	427	203
Annual %Growth 2000-4	33	28	26
Annual %Growth 2004-5	39	96	19

Notes: Panels report annual export value and number of exporters by classification. OTC and MFA represent quota-free and quota-bound exports, respectively (see text). The Final column summarizes China's total exports of all HS chapters in the noted year.

Table 3: 2004 versus 2005 Export Value Market Shares, by Type of Firm and by Product

	Value Market Share, 2004		
	OTC	MFA	Total
SOE	0.44	0.54	0.26
Domestic	0.29	0.24	0.17
Foreign	0.26	0.23	0.57
Total	1.00	1.00	1.00

	Value Market Share, 2005		
	OTC	MFA	Total
SOE	0.36	0.38	0.22
Domestic	0.34	0.32	0.19
Foreign	0.30	0.30	0.59
Total	1.00	1.00	1.00

	Difference in Value Market Share, 2005		
	OTC	MFA	MFA
SOE	-0.08	-0.16	-0.04
Domestic	0.05	0.09	0.02
Foreign	0.04	0.07	0.02

Note: Table reports export-value market share by type of firm in 2004 and 2005, as well as the change in market share between 2004 and 2005.

Table 4: Aggregate TFP Gain Following Quota Removal

Ownership	Average Relative TFP	Relative Market Share Change	TFP Change
State-Owned Enterprises	0.82	-0.159	-0.130
Private Enterprises	1.76	0.086	0.152
Foreign Enterprises	1.54	0.073	0.113
Overall			0.135

Notes: Table reports aggregate changes in relative productivity by ownership for MFA in 2005 relative to control groups. See text for a description of how TFP measures are calculated from the Annual Survey of Industries. The first column reports for each ownership type the mean TFP relative to the industry mean. These averages correspond to the averages reported in the corresponding Figure 1. The relative change in market shares in the second column are taken from Table 3 bottom panel). The third column multiplies the change in market share with the average productivity measure. The final row is the sum of first three rows.

Table 5: Decomposition of Absolute and Relative 2004 to 2005 Changes in MFA Market Share

Margin	Single Difference				Triple Difference			
	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign
Incumbents	-0.210	-0.159	-0.033	-0.018	-0.167	-0.142	-0.022	-0.003
Net Entry								
Adders	0.647	0.260	0.252	0.135	0.164	0.018	0.075	0.071
New Exporters	0.064	0.003	0.046	0.014	0.027	-0.002	0.025	0.005
Exiters	-0.501	-0.323	-0.132	-0.046	-0.024	-0.006	-0.010	-0.007
Total Net Entry	0.210	-0.060	0.167	0.103	0.167	0.009	0.090	0.068
Total	0.000	-0.219	0.134	0.085	0.000	-0.133	0.068	0.065

Notes: Left panel reports average change in 2004 to 2005 quantity-based market share across MFA product-country pairs by margin of adjustment and firm ownership type. Right panel reports average 2004 to 2005 versus 2003 to 2004 changes in MFA versus OTC quantity-based market shares across product-country pairs by margin of adjustment and firm ownership type. In both panels, rows 2 to 4 sum to row 5, and rows 1 and 5 sum to row 6. The first column is sum of the remaining columns. Results are generated using the regression noted in the text (the full regression results are reported in Table 10). Estimated coefficients are bold if they are statistically significant at the 10 percent level or better.

Table 6: Decomposition of Absolute and Relative 2004 to 2005 Changes in MFA Prices

Margin	Single Difference				Triple Difference			
	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign
Incumbents (I)								
Within	-0.017	-0.013	-0.003	0.000	-0.025	-0.016	-0.007	-0.002
Across	-0.039	-0.033	-0.006	-0.001	-0.042	-0.036	-0.009	0.003
Entrant (N)	-0.100	-0.025	-0.056	-0.019	-0.070	-0.027	-0.033	-0.010
Exiter (X)	0.023	0.021	-0.002	0.003	0.043	0.024	0.017	0.002
Net Entry (N-X)	-0.123	-0.047	-0.054	-0.022	-0.113	-0.051	-0.049	-0.012
Total	-0.179	-0.093	-0.063	-0.023	-0.179	-0.103	-0.065	-0.011
Extensive Share	0.687	0.505	0.858	0.958	0.629	0.494	0.763	1.075

Notes: Left panel reports average change in 2004 to 2005 export price across MFA product-country pairs by margin of adjustment and firm ownership type. Right panel decomposes 2004-5 versus 2003-4 relative changes in MFA versus OTC export price by margin of adjustment and firm ownership type. Rows 3 and 4 sum to row 5. Rows 1, 2 and 5 sum to row 6. The first column is the sum of remaining columns. Results are generated using the regression noted in the text (the full regression results are reported in Table 11). The final row reports the contribution of the extensive margin to the total price change of each column. Coefficients in bold are statistically significant at the 10 percent level or better.

Table 7: Decomposition of Absolute and Relative Changes in MFA Quality

Margin	Single Difference				Triple Difference			
	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign
Incumbents (I)	0.019	-0.006	0.012	0.013	-0.052	-0.026	-0.017	-0.009
Entrant (N)	-0.049	-0.008	-0.035	-0.006	-0.030	-0.010	-0.018	-0.002
Exiter (X)	-0.074	-0.039	-0.027	-0.007	0.027	0.004	0.015	0.008
Net Entry (N-X)	0.025	0.032	-0.009	0.002	-0.057	-0.014	-0.032	-0.011
Total	0.044	0.026	0.004	0.014	-0.109	-0.040	-0.050	-0.020
Extensive Share	0.567	1.230	-2.342	0.121	0.523	0.352	0.651	0.551

Notes: Left panel reports average change in 2004 to 2005 export quality across MFA product-country pairs by margin of adjustment and firm ownership type. See text for definition of quality. Right panel decomposes 2004-5 versus 2003-4 relative changes in MFA versus OTC export quality by margin of adjustment and firm ownership type. Rows 2 to 3 sum to row 4. Rows 1 and 4 sum to row 5. The first column is sum of remaining columns. Results are generated using the regression noted in the text (the full regression results are reported in Table 12). The final row reports the contribution of the extensive margin to the total quality change of each column. Coefficients in bold are statistically significant at the 10 percent level or better.

Table 8: Decomposition of Absolute and Relative 2004 to 2005 Changes in MFA Quality-Adjusted Prices

Margin	Single Difference				Triple Difference			
	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign
Incumbents (I)	-0.075	-0.040	-0.021	-0.014	-0.014	-0.026	0.002	0.010
Entrant (N)	-0.051	-0.017	-0.020	-0.013	-0.039	-0.017	-0.015	-0.007
Exiter (X)	0.097	0.061	0.025	0.011	0.016	0.020	0.002	-0.006
Net Entry (N-X)	-0.147	-0.078	-0.045	-0.024	-0.055	-0.037	-0.017	-0.002
Total	-0.222	-0.118	-0.067	-0.037	-0.070	-0.063	-0.015	0.008
Extensive Share	0.664	0.662	0.682	0.637	0.794	0.585	1.133	-0.190

Notes: Left panel reports average change in 2004 to 2005 export quality-adjusted prices across MFA product-country pairs by margin of adjustment and firm ownership type. See text for definition of quality. Right panel decomposes 2004-5 versus 2003-4 relative changes in MFA versus OTC export quality-adjusted prices by margin of adjustment and firm ownership type. Rows 2 to 3 sum to row 4. Rows 1 and 4 sum to row 5. The first column is the sum of remaining columns. Results are generated using the regression noted in the text (the full regression results are reported in Table 13). The final row reports the contribution of the extensive margin to the total quality-adjusted price change of each column. Coefficients in bold are statistically significant at the 10 percent level or better.

Table 9: Decomposition of 2004 to 2005 Changes in Relative MFA Market Share, Processing Exports

Margin	All Exports				Processing Exports			
	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign
Incumbents	-0.167	-0.142	-0.022	-0.003	-0.217	-0.150	-0.022	-0.044
Net Entry								
Adders	0.164	0.018	0.075	0.071	0.149	-0.028	-0.009	0.186
New Exporters	0.027	-0.002	0.025	0.005	0.038	0.011	-0.002	0.029
Exiters	-0.024	-0.006	-0.010	-0.007	0.029	0.009	0.016	0.005
Total Net Entry	0.167	0.009	0.090	0.068	0.217	-0.008	0.005	0.220
Total	0.000	-0.133	0.068	0.065	0.000	-0.158	-0.017	0.175

Notes: Table reports average 2004 to 2005 versus 2003 to 2004 changes in MFA versus OTC quantity-based market shares across product-country pairs by margin of adjustment and firm ownership type. The left panel re-produces the figures in Table 4, and the right panel is restricted to processing exports. In each panel, rows 3 to 5 sum to row 6. Final row is sum of rows 1 and 6. The first column is the sum of the remaining columns. Results are generated using the regression noted in the text. Estimated coefficients in first five rows are bold if they are statistically significant at the 10 percent level or better.

Figure 1: Textile and Apparel Producers' TFP, 2005

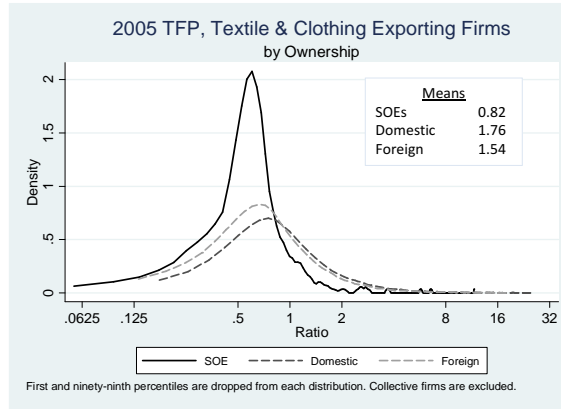


Figure 2: MFA Incumbents' 2004-5 Change in Market Share vs Initial 2004 Level

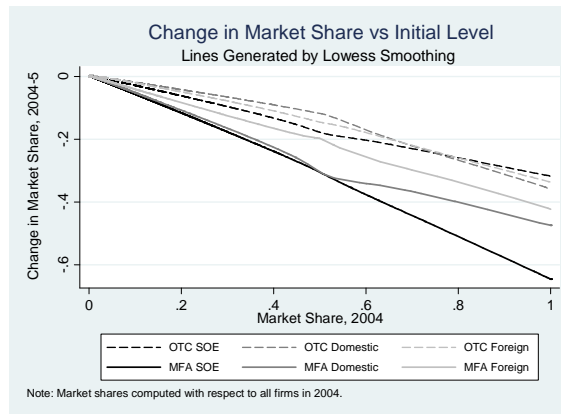


Figure 3: Average Export Price Growth Across Product-Country Pairs, by Group and Year

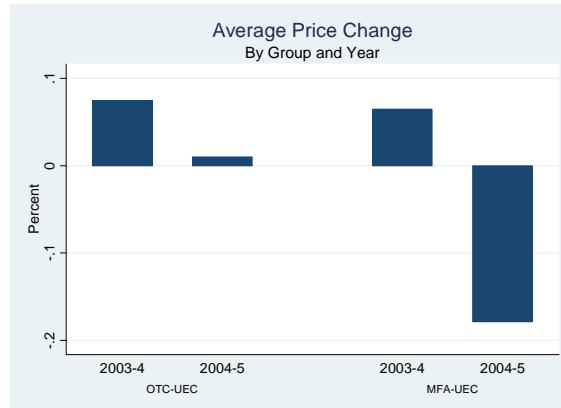


Figure 4: MFA Export Prices Relative to the Average Export Price Across All Firms in 2004 and 2005, by Margin

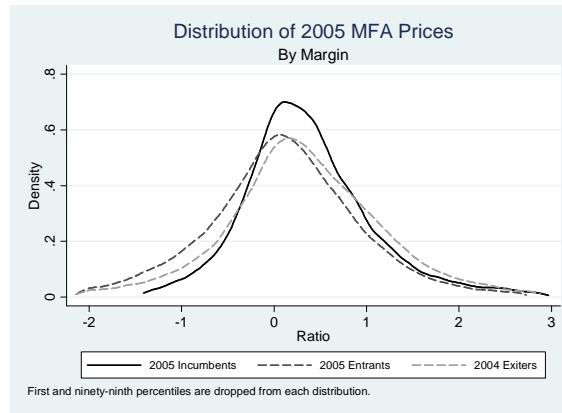
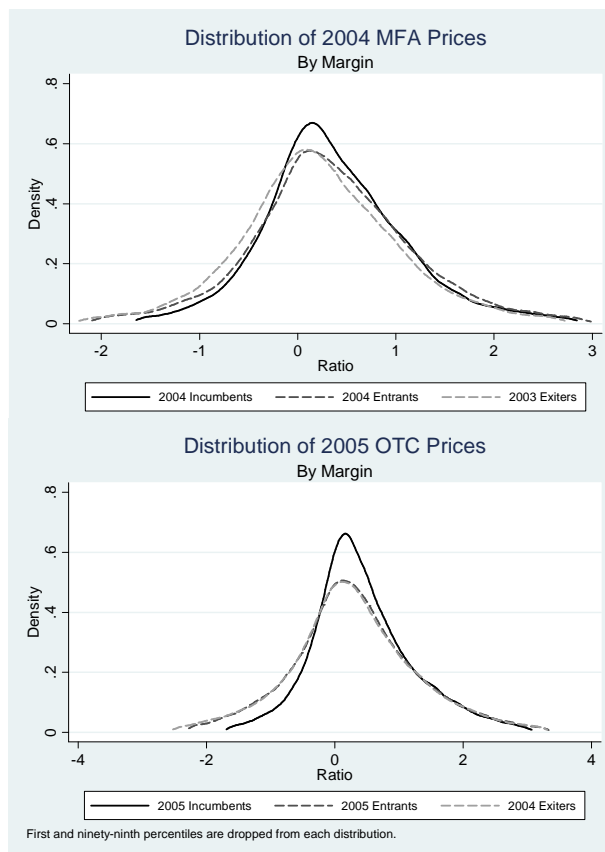


Figure 5: Exitors versus Entrants in 2005 OTC and 2004 MFA



A Appendix (Numerical Solutions)

In this appendix, we provide further detail on Irarrazabal et. al (2010) and our procedures for solving the model numerically.

There is one industry and two countries, although this is easily generalized to multiple countries and multiple industries. A representative consumer maximizes a CES utility function

$$U = \left(\int_{\omega \in \Omega} q(\omega)^{(\sigma-1)/\sigma} d\omega \right)^{\sigma/(\sigma-1)} \quad (\text{A.12})$$

Firms face three types of costs. The first two are the standard: *ad valorem* tariffs (τ_{od}) and fixed costs of production (f_{od}). In order to export a quota-bound good from origin country o to destination country d , firms must also pay a license fee ($a_{od} > 0$) per unit exported. This quota license fees is equivalent to per-unit increases in the cost of exporting.

Firm productivity is drawn from the distribution $G(\varphi)$ with density $g(\varphi)$. The price of variety φ in export market d is given by

$$p_{od}(\varphi, a_{od}) = \frac{\sigma}{\sigma-1} \omega_o \left(\frac{\tau_{od}}{\varphi} + a_{od} \right), \quad (\text{A.13})$$

where $\sigma > 1$ is the constant elasticity of substitution across varieties and ω_o is the wage in the origin country. The corresponding export quantity is given by

$$q_{od}(\varphi, a_{od}) = \left(\frac{\sigma}{\sigma-1} \omega_o \right)^{-\sigma} \left(\frac{\tau_{od}}{\varphi} + a_{od} \right)^{-\sigma} (P_d)^{\sigma-1} Y_d, \quad (\text{A.14})$$

where P_d and Y_d are the price index and expenditure in the destination market, respectively. The license price that equates the aggregate demand for exports with the size of the quota is determined (endogenously) by a Walrasian auctioneer.

This model assumes that the total mass of potential entrants in each country is proportional to a country's income. Since there is no free entry, net profits are pooled and redistributed to consumers in country o who own ω_o of a diversified global fund. Total income in each country is $Y_o = \omega_o L_o (1 + \pi)$ where π is the dividend per share of the global fund. The profits for country o 's active firms selling to market d are $\pi_{od} = \frac{p_{od} q_{od}}{\sigma} - n_{od} f_{od}$, so

$$\pi = \frac{\sum_{o,d} \pi_{od}}{\sum_o \omega_o L_o}. \quad (\text{A.15})$$

Firms maximize the following profits separately to each destination

$$q_{od}(\varphi, a_{od}) \left[p_{od}(\varphi, a_{od}) - \omega_o \left(\frac{\tau_{od}}{\varphi} + a_{od} \right) \right] - \omega_o f_{oo}, \quad (\text{A.16})$$

where f_{oo} is the fixed cost of production in the home profit equation and f_{od} is the fixed cost of exporting from o to d .

Firms enter a market if there are positive profits. The marginal exporter earns zero profits and is identified as

$$\varphi_{od}^* = \left[\left(\frac{\sigma - 1}{\sigma} \right) \sigma^{\frac{1}{1-\sigma}} \left(\frac{\omega_o f_{od}^x}{Y_d} \right)^{\frac{1}{1-\sigma}} \frac{P_d}{\omega_o \tau_{od}} - \frac{a_{od}}{\tau_{od}} \right]^{-1}, \quad (\text{A.17})$$

where $P_d = P_d(\varphi_{od}^*)$. Given φ_{od}^* , we can express the price index in country d as

$$P_d^{1-\sigma} = \omega_o L_o \int_{\varphi_{od}^*}^{\infty} p_{od}(\varphi, a_{od})^{1-\sigma} dG(\varphi) \varphi \quad (\text{A.18})$$

Since there is no closed form solution to the price index when $a_{od} > 0$, we must solve the model numerically. Our solution modifies the algorithm described in Irarrazabal et al (2010) to account for an endogenous license price. The parameters are: σ , $L = L_{Chn}, L_{UEC}$, $G(\varphi) \sim \ln \mathcal{N}(\mu, \theta)$, $\tau = \{\tau_{Chn,Chn}, \tau_{Chn,UEC}, \tau_{UEC,Chn}, \tau_{UEC,UEC}\}$, $f = \{f_{Chn,Chn}, f_{Chn,UEC}, f_{UEC,Chn}, f_{UEC,UEC}\}$, $\omega = \{\omega_{Chn}, \omega_{UEC}\}$. Below we explain how the parameters are chosen. Given the parameters, we can numerically solve for the endogenous variables of the model: $\varphi^* = \{\varphi_{Chn,Chn}^*, \varphi_{Chn,UEC}^*, \varphi_{UEC,Chn}^*, \varphi_{UEC,UEC}^*\}$, $P = \{P_{Chn}, P_{UEC}\}$, $Y = \{Y_{Chn}, Y_{UEC}\}$, π and $a_{Chn,UEC}$ (we assume that China does not impose quotas on U.S. goods).

We solve two versions of the model. The first version does not impose quotas on China's exports to the U.S. (the "no quota" equilibrium). In this scenario, $a_{Chn,UEC} = 0$. In the "efficient allocation" equilibrium, the license price is non-negative and depends on the restrictiveness of the quotas that we calculate from the data.

We solve the model with one million firms drawn from the productivity distribution. The Matlab code used to generate these results, available in our electronic

appendix, is a modified version of the code used in Irarrazabal et al. (2010), graciously provided by Andreas Moxnes. Superscripts denoting the iteration round:

1. Choose a starting value for the license price a_{od}^0 . (In the “no quota” equilibrium, we set $a_{od}^0 = 0$.)
2. Choose a starting value for the price indexes, P^0 .
3. Simultaneously solve for the dividend per share in equation (A.15) and the cutoffs φ^* in equation (A.17). This involves solving five unknowns with five equations. First choose a candidate π and then compute the cutoffs in (A.17). Given the candidate φ^* , compute π and re-compute the cutoffs, iterating until convergence is achieved. This process determines the cutoffs φ^{0*} given the candidate P^0 in step 2.
4. Compute the price indexes in (A.18).
5. Iterate over steps 3 and 4. The equilibrium values of $\{\varphi^*, P\}$ are found when $\|P^r - P^{r-1}\|$ is minimized. The values of Y and π are determined once $\{\varphi^*, P\}$ are known. In the “no quota” equilibrium, stop here and compute aggregate exports from China to the US. In the “efficient allocation” equilibrium, continue to step 6.
6. Compare aggregate exports from China to the U.S. with exports under “no quota” equilibrium multiplied by the quota restrictiveness. Iterate on steps 1-5 until this difference is minimized.

We impose values for some parameters and choose values for the remaining parameters by gridding over them and comparing their solutions to the data. We assume that the two countries have identical sizes $L_{UEC} = L_{Chn} = 100$. We choose an elasticity of substitution, $\sigma = 4$, that is the median among the apparel and textiles elasticities estimated in Broda et al. (2006). We assume a log normal productivity distribution, $G(\varphi) \sim \ln \mathcal{N}(\mu, \theta)$. We assume iceberg trade costs are equal to 1 within countries, ($\tau_{Chn,Chn} = \tau_{US,US} = 1$). We assume domestic fixed costs of production are low enough to allow all firms to produce and set them to $f_{Chn,Chn} = f_{UEC,UEC} = 2 \times 10^{-6}$. We set the wage in each country equal to unity; although this assumption appears strong, it simply implies that the iceberg and fixed trade costs that we match to the data capture variation in wages as well as trade costs. Although this assumption appears strong, it simply implies that

the iceberg and fixed trade costs that we match to the data capture variation in wages as well as trade costs.

We jointly choose the remaining parameters – the log normal mean and standard deviation, the two iceberg trade costs ($\tau_{Chn,UEC}$ and $\tau_{UEC,Chn}$) and the ratios of exporting to domestic fixed costs ($f_{Chn,UEC}$ and $f_{UEC,Chn}$) – to match the following features of the data: the 75th, 90th, 95th, 99th and 99.9th percentiles of the distribution of exports among Chinese textile and clothing exporters, the share of Chinese textile and clothing producers that export and the Chinese and U.S. market shares of U.S. and Chinese textile and clothing consumption in 2005, respectively. China’s NBS production data reports that 44 percent of firms in the textile and clothing sectors (Chinese Industrial Classifications 17 and 18) exported in 2005. The share exports accounted for by the {75th,90th,95th,99th,99.9th} percentiles of these exporters is {0.26,0.46,0.59,0.80,0.93}. According to textile and clothing production and trade data in the Annual Survey and Chinese customs data, respectively, the U.S. market share of Chinese textile and clothing (China Industrial Classification codes 17 and 18) consumption is 1.2 percent. According to the NBER Productivity Database, the Chinese market share of U.S. apparel and textile consumption (NAICS codes 313, 314 and 315) is 13.1 percent. All data are from 2005 because that is the first post-quota year. The resulting parameters are $\mu = 1.29$, $\theta = 0.58$, $\tau_{Chn,UEC} = 1.80$, $\tau_{UEC,Chn} = 3.55$, $f_{Chn,UEC}/f_{Chn,Chn} = 1.15$ and $f_{UEC,Chn}/f_{UEC,UEC} = 1.15$. The model matches the moments we target well: The share exports accounted for by the {75th,90th,95th,99th,99.9th} percentiles is {0.32,0.52,0.65,0.84,1}; 44 percent of the simulated Chinese firms export and they have a 13.5 percent market share in the U.S.; and 8 percent of the simulated U.S. firms export and have a 1.2 percent market share in China. The sum of the squared deviations between model and data in percentage terms is 0.43.

Finally, we need one more parameter, the quota restrictiveness, to solve the “efficient allocation” simulation. According to the data, the median growth of Chinese exports of quota-restricted goods relative to unrestricted goods was 155 percent in 2005 relative to 2004. This implies a quota restrictiveness of 0.61 ($1 - 1/2.55$).³⁴

³⁴This 155 percent growth rate is relative to quota-unconstrained textile and clothing exports as well as to export growth of both types of exports in 2004, i.e., a “triple” difference that is explained in greater detail in Section 4.3. We assume this measure of quota restrictiveness is

B Appendix (Empirical Results)

Table 10 contains the underlying regression output for the results reported in Table 5. Table 11 contains the underlying regression output for the results reported in Table 6. Table 12 contains the underlying regression output for the results reported in Table 7. Table 13 contains the underlying regression output for the results reported in Table 8.

independent of whether quotas are allocated efficiently or inefficiently in 2004.

Appendix Tables

Table 10: Regression Output for Table 5

	Incumbent			Exiters			Adder			New Exporter						
	All	SOE	Domestic	All	SOE	Domestic	All	SOE	Domestic	All	SOE	Domestic	All	SOE	Domestic	Foreign
1{2005}	-0.023	-0.005	-0.006	-0.011	0.021	-0.017	-0.001	0.017	-0.050	0.060	0.007	-0.016	-0.005	-0.013	0.003	0.003
	0.010	0.007	0.005	0.005	0.009	0.007	0.006	0.009	0.007	0.007	0.006	0.006	0.002	0.005	0.005	0.003
1{MFA}	0.026	0.023	0.001	0.001	-0.024	-0.077	0.022	0.031	0.060	-0.009	-0.020	-0.033	0.002	0.026	-0.008	-0.008
	0.011	0.009	0.005	0.004	0.015	0.013	0.009	0.006	0.015	0.013	0.009	0.006	0.002	0.005	0.002	0.002
x 1{2005}	-0.167	-0.142	-0.022	-0.003	-0.024	-0.006	-0.010	-0.007	0.164	0.018	0.075	0.027	-0.002	0.025	0.005	0.005
	0.017	0.014	0.008	0.007	0.016	0.016	0.012	0.008	0.015	0.014	0.013	0.009	0.002	0.006	0.003	0.003
Constant	-0.047	-0.036	-0.005	-0.005	-0.474	-0.279	-0.126	-0.069	0.435	0.233	0.125	0.077	0.086	0.009	0.061	0.016
	0.007	0.005	0.003	0.003	0.010	0.008	0.006	0.004	0.009	0.007	0.005	0.004	0.001	0.004	0.004	0.002
Observations	5,213	5,213	5,213	5,213	5,213	5,213	5,213	5,213	5,213	5,213	5,213	5,213	5,213	5,213	5,213	5,213
R-squared	0.05	0.05	0.01	0.00	0.00	0.02	0.00	0.01	0.05	0.02	0.05	0.02	0.01	0.01	0.01	0.00
Single Difference	-0.210	-0.159	-0.033	-0.018	-0.501	-0.323	-0.132	-0.046	0.647	0.260	0.252	0.064	0.003	0.046	0.014	0.014
Double Difference	-0.141	-0.118	-0.021	-0.002	-0.048	-0.083	0.011	0.024	0.195	0.077	0.067	-0.006	0.000	-0.002	-0.004	-0.004
Triple Difference	-0.167	-0.142	-0.022	-0.003	-0.024	-0.006	-0.010	-0.007	0.164	0.018	0.075	0.071	-0.002	0.025	0.005	0.005

Notes: Table displays the regression of change in noted quantity market share margin on noted dummy variables (see text), by firm ownership. Sample includes all product country pairs in groups MFA and OTC and years 2004 and 2005. Single difference refers to mean 2004 to 2005 change in quantity market share across product-country pairs in MFA. Double difference refers to the single difference mean less the analogous mean for OTC. Triple difference refers to 2005 double difference mean less the 2004 double difference mean. Standard errors are adjusted for clustering at the eight-digit HS level.

Table 11: Regression Output for Table 6

	Incumbent - Within			Incumbent - Across			Entrant			Exiters			Total Change			
	All	SOE	Domestic	All	SOE	Domestic	All	SOE	Domestic	All	SOE	Domestic	All	SOE	Domestic	Foreign
1{2005}	-0.010	-0.010	0.000	-0.001	-0.002	0.001	0.000	0.000	-0.026	-0.002	-0.017	-0.006	-0.012	0.001	-0.001	-0.034
	0.007	0.005	0.003	0.004	0.007	0.005	0.003	0.013	0.007	0.007	0.006	0.010	0.007	0.004	0.005	0.028
1{MFA}	-0.008	-0.004	-0.001	-0.003	0.008	0.007	0.004	-0.003	0.005	0.006	0.006	-0.007	0.000	0.003	0.003	-0.006
	0.007	0.005	0.003	0.003	0.006	0.005	0.002	0.003	0.012	0.008	0.006	0.005	0.009	0.007	0.003	0.004
x 1{2005}	-0.025	-0.016	-0.007	-0.002	-0.042	-0.036	-0.009	0.003	-0.070	-0.027	-0.033	-0.010	-0.066	-0.052	-0.015	0.001
	0.009	0.007	0.004	0.004	0.010	0.007	0.004	0.004	0.018	0.011	0.010	0.008	0.013	0.010	0.005	0.006
Constant	0.026	0.017	0.004	0.006	-0.004	-0.002	-0.002	0.000	-0.009	-0.003	-0.011	0.005	0.022	0.015	0.002	0.005
	0.005	0.004	0.002	0.002	0.004	0.003	0.002	0.002	0.008	0.005	0.004	0.004	0.006	0.005	0.002	0.003
Observations	5,213	5,213	5,213	5,213	5,213	5,213	5,213	5,213	5,213	5,213	5,213	5,213	5,213	5,213	5,213	5,213
R-squared	0.01	0.01	0.00	0.01	0.01	0.01	0.00	0.00	0.01	0.00	0.01	0.00	0.02	0.02	0.00	0.02
Single Difference	-0.017	-0.013	0.000	-0.003	-0.039	-0.033	-0.006	-0.001	-0.100	-0.025	-0.056	-0.019	-0.056	-0.046	-0.009	-0.001
Double Difference	-0.033	-0.020	-0.007	-0.005	-0.034	-0.029	-0.005	0.000	-0.065	-0.021	-0.027	-0.017	-0.066	-0.049	-0.012	-0.005
Triple Difference	-0.025	-0.016	-0.007	-0.002	-0.042	-0.036	-0.009	0.003	-0.070	-0.027	-0.033	-0.010	-0.066	-0.052	-0.015	0.001

Notes: Table displays the regression of change in noted price margin on noted dummy variables by firm ownership. Sample includes all product country pairs in groups MFA and OTC and years 2004 and 2005. Single difference refers to mean 2004 to 2005 change in prices across product-country pairs in MFA. Double difference refers to the single difference mean less the analogous mean for OTC. Triple difference refers to 2005 double difference mean less the 2004 double difference mean. Standard errors are adjusted for clustering at the eight-digit HS level.

Table 12: Regression Output for Table 7

	Incumbent			Entrant			Exit			Total Change					
	All	SOE	Domestic	All	SOE	Domestic	All	SOE	Domestic	All	SOE	Domestic			
1{2005}	0.077	0.026	0.027	0.024	0.028	0.000	0.004	0.077	0.026	0.027	0.024	0.122	0.049	0.040	0.033
0.014	0.009	0.006	0.007	0.015	0.009	0.009	0.007	0.014	0.009	0.006	0.007	0.035	0.021	0.015	0.013
1{MFA}	-0.013	-0.007	0.002	-0.008	0.011	0.007	0.014	-0.013	-0.007	0.002	-0.008	-0.019	-0.010	0.001	-0.010
0.013	0.010	0.006	0.005	0.015	0.011	0.008	0.006	0.013	0.010	0.006	0.005	0.032	0.022	0.013	0.011
x 1{2005}	-0.052	-0.026	-0.017	-0.009	-0.030	-0.010	-0.018	-0.052	-0.026	-0.017	-0.009	-0.109	-0.040	-0.050	-0.020
0.019	0.014	0.008	0.008	0.023	0.014	0.013	0.009	0.019	0.014	0.008	0.008	0.050	0.033	0.022	0.017
Constant	0.008	0.001	0.001	0.005	-0.057	-0.029	-0.032	0.008	0.001	0.001	0.005	0.049	0.026	0.013	0.011
0.009	0.007	0.003	0.004	0.010	0.007	0.006	0.005	0.009	0.007	0.003	0.004	0.021	0.013	0.009	0.008
Observations	5,213	5,213	5,213	5,213	5,213	5,213	5,213	5,213	5,213	5,213	5,213	5,213	5,213	5,213	5,213
R-squared	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.00	0.00	0.00
Single Difference	0.019	-0.006	0.012	0.013	-0.049	-0.008	-0.035	-0.006	0.019	-0.006	0.012	0.044	0.026	0.004	0.014
Double Difference	-0.065	-0.033	-0.016	-0.017	-0.020	-0.003	-0.003	-0.013	-0.065	-0.033	-0.016	-0.128	-0.050	-0.048	-0.030
Triple Difference	-0.052	-0.026	-0.017	-0.009	-0.030	-0.010	-0.018	-0.002	-0.052	-0.026	-0.017	-0.109	-0.040	-0.050	-0.020

Notes: Table displays the regression of change in noted quality margin on noted dummy variables by firm ownership. See text for definition of quality. Sample includes all product country pairs in groups MFA and OTC and years 2004 and 2005. Single difference refers to mean 2004 to 2005 change in quality across product-country pairs in MFA. Double difference refers to the single difference mean less the analogous mean for OTC. Triple difference refers to 2005 double difference mean less the 2004 double difference mean. Standard errors are adjusted for clustering at the eight-digit HS level.

Table 13: Regression Output for Table 8

	Incumbent			Entrant			Exit			Total Change					
	All	SOE	Domestic	All	SOE	Domestic	All	SOE	Domestic	All	SOE	Domestic			
1{2005}	-0.088	-0.038	-0.025	-0.025	-0.053	-0.017	-0.011	-0.088	-0.038	-0.025	-0.025	-0.186	-0.083	-0.057	-0.046
0.007	0.005	0.003	0.004	0.008	0.005	0.004	0.003	0.007	0.005	0.003	0.004	0.017	0.010	0.007	0.007
1{MFA}	0.013	0.010	0.002	-0.006	-0.002	-0.008	0.004	0.013	0.010	0.002	0.002	0.009	0.009	0.000	0.000
0.008	0.006	0.004	0.003	0.008	0.006	0.004	0.003	0.008	0.006	0.004	0.003	0.017	0.012	0.007	0.005
x 1{2005}	-0.014	-0.026	0.002	0.010	-0.039	-0.017	-0.015	-0.007	-0.014	-0.026	0.002	-0.070	-0.063	-0.015	0.008
0.011	0.009	0.005	0.005	0.013	0.008	0.007	0.004	0.011	0.009	0.005	0.005	0.028	0.019	0.012	0.008
Constant	0.014	0.014	0.001	0.000	0.048	0.026	0.020	0.014	0.014	0.001	0.000	0.025	0.018	0.006	0.001
0.005	0.004	0.002	0.002	0.005	0.003	0.003	0.002	0.005	0.004	0.002	0.002	0.011	0.007	0.005	0.004
Observations	5,213	5,213	5,213	5,213	5,213	5,213	5,213	5,213	5,213	5,213	5,213	5,213	5,213	5,213	5,213
R-squared	0.06	0.03	0.02	0.02	0.03	0.02	0.01	0.06	0.03	0.02	0.02	0.06	0.04	0.03	0.02
Single Difference	-0.075	-0.040	-0.021	-0.014	-0.051	-0.017	-0.020	-0.013	-0.075	-0.040	-0.021	-0.222	-0.118	-0.067	-0.037
Double Difference	-0.001	-0.016	0.004	0.012	-0.045	-0.018	-0.023	-0.004	-0.001	-0.016	0.004	-0.061	-0.053	-0.015	0.008
Triple Difference	-0.014	-0.026	0.002	0.010	-0.039	-0.017	-0.015	-0.007	-0.014	-0.026	0.002	-0.070	-0.063	-0.015	0.008

Notes: Table displays the regression of change in noted quality-adjusted price margin on noted dummy variables by firm ownership. See text for definition of quality-adjusted prices. Sample includes all product country pairs in groups MFA and OTC and years 2004 and 2005. Single difference refers to mean 2004 to 2005 change in quality-adjusted prices across product-country pairs in MFA. Double difference refers to the single difference mean less the analogous mean for OTC. Triple difference refers to 2005 double difference mean less the 2004 double difference mean. Standard errors are adjusted for clustering at the eight-digit HS level.