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ABSTRACT

Trade liberalization and Embedded Institutional Reform: Evidence from Chinese Exporters*

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 removal of externally imposed quotas. Both the surge in export volumes and the decline in prices after the quota removal are driven by net entry, implying that the pre-liberalization quota allocation is not based on firm productivity. Removing this misallocation accounts for a substantial share of the overall productivity gains associated with the quota removal.

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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 (e.g., arbitrary enforcement of quotas and tariffs). 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 U.S., the E.U. 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 a simple model of heterogeneous-firm exporting in the style of Melitz (2003) and Chaney (2008). In this model, firms access the export market by paying a per-unit fee that equates the supply and demand for quota.[1] 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

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[1]Irarrazabal, Moxnes and Opromolla (2010) and Berman, Martin and Mayer (2012) are recent papers that introduce specific costs into the Melitz model.

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 identical textile and clothing products exported quota free. This identification strategy exploits variation in the application of quotas across developed-country markets, thereby isolating the influence of quota allocation from other factors affecting Chinese textile and clothing exports more broadly. Shipments of "men's cotton pajamas", for example, were subject to quotas in the United States and Canada prior to 2004, but free of quotas in the E.U. market. Contrasting their growth in the years before and after quotas are removed controls for other shocks to supply and demand, such as privatization and changes in consumer preferences, respectively.

Substantial deviations between the auction-allocation model and the data indicate that the government institution in charge of distributing quotas misallocated licenses with respect to firm productivity.[2] We show that the strong export growth and the sharp price declines that follow quota removal are driven by net entry rather than incumbents. We then highlight three features of the data that demonstrate entrants are *more* productive than the firms that exported under quotas. First, their prices are substantially lower than the prices of exiters, such that net entrants account for 68 percent of the overall 17 percentage point decline in relative prices. Second, entrants emerge from the private sector and gain market share at the expense of relatively unproductive state-owned enterprises (SOEs). Finally, incumbents with the highest market share under quotas experienced the largest decline in market share when quotas were removed. All of these trends

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[2]We 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 present, our results can be interpreted as measuring the cost of pursuing them in terms of exporter efficiency.

contrast starkly with the model's prediction that high-productivity incumbents benefit disproportionately from the removal of license fees.[3]

In the second part of the paper we use numerical solutions of the model to estimate the contribution of embedded institutional reform to overall productivity growth. As we do not know how the government actually assigned quotas, we construct a coarse political-allocation scenario calibrated to the observed influence of the extensive margin in our empirical results. We compute the change in firms' weighted average productivity in moving from political to auction allocation and then from auction allocation to no quotas. We find that 71 percent of the overall gain in productivity from removing quotas is due to the elimination of the quota misallocation versus 29 percent for the removal of the quota itself. Applying this 71 percent contribution to back-of-the-envelope estimates of the overall productivity gain derived from our empirical analysis, we estimate that replacing the government's actual licensing institution with an auction would raise industry productivity by 15 percentage points. This estimate appears plausible given Hsieh and Klenow's (2009) conclusion that removing all domestic distortions from the Chinese economy would raise total factor productivity by 87 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 United States.[4] 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 reallo-

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

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

cation 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 the same textile and clothing products exported to different markets. 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 are present in other export markets, the economy-wide productivity loss associated with suppression of the extensive margin (via barriers to entry) might be 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.[5] 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

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[5]See Feenstra (1992) for an overview of this literature. Bhagwati (1982) discusses the many "directly unproductive", profit-seeking activities, such as bribe-taking, that often accompany implementation of trade protection. Harrigan and Barrows (2009), Brambilla, Khandelwal and Schott (2010), Krishna and Tan (1998) and Bernhofen, Upward and Wang (2011) offer discussions focused on the MFA.

institution.

The rest of the paper proceeds as follows. Section I briefly presents a model of quota allocation that is used to guide the empirical analysis. Section II offers a summary of the Multifiber Arrangement. Section III describes our data and Section IV contains our empirical analysis. Section V describes our counter-factual analysis. Section VI concludes. We refer the reader to our electronic appendix for additional results.

I   Allocating Export Quotas by Auction

We employ a simple model of heterogeneous firms to guide our empirical examination of exporting under quotas. In the model, firms obtain licenses to export under the quota from a government auction. While high-productivity (low-price) exporters are relatively more able to absorb the per-unit license fee that clears the auction, their export volume is disproportionately penalized by the fee. As a result, the model demonstrates that when quotas are removed, the exports of high-productivity incumbents grow disproportionately. In Section III, we show that this prediction is starkly violated in the data, indicating that the actual manner in which China allocated export licenses did not channel them to its most productive exporters.

The model encompasses a single industry and two countries where the representative consumer in the export market c maximizes a CES utility function, $U = \left(\int_{\zeta \in \Omega} [q_c(\zeta)]^{(\sigma-1)/\sigma} \, d\zeta \right)^{\sigma/(\sigma-1)}$. These preferences yield the demand curve $q_c(\zeta) = p_c(\zeta)^{-\sigma} P_c^{\sigma-1} Y_c$, where P_c and Y_c are the overall price index and expenditure in the export market, and $\sigma > 1$ is the elasticity of substitution across varieties (indexed by ζ).

Firms face an aggregate export quota determined exogenously via bilateral negotiations between the two countries. We assume that quota licenses are competitively auctioned in the origin market which endogenously determines the per-unit license price a_c.[6] As in Demidova, Kee and Krishna (2009), firms must pay this

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[6]This license price is equivalent to the shadow price of the aggregate quota constraint in a standard formulation of firms maximizing profits subject to a quota constraint (e.g., Feenstra 2004). Here, we assume that the government extracts the quota rents by charging firms the license fee.

license fee for each unit they export to the destination market; intuitively, it falls 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.

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

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

where ω_o is the wage in the origin country (labor is the only factor) and τ_{oc} is the iceberg trade cost to reach destination c from o. 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. In Melitz (2003), the ratio of output produced by two firms with productivity $\varphi > \varphi'$ is independent of trade costs. Here, this independence is broken by the addition of the quota license fee. The key result is that reductions in the license fee induce relatively greater growth among low-priced firms. We note that even if firms are not required to pay a license price (i.e., the government allows the firms to keep the rents), firm prices will be distorted in exactly the same way as (1) where the license fee becomes the shadow price on the quantity constraint faced by the firm. We choose to assume the government extracts the rent from the firms since an auction is a feasible mechanism to allocate licenses by the government.

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

$$\varphi_{oc}^* = \left[\left(\frac{\sigma - 1}{\sigma}\right)\sigma^{\frac{1}{1-\sigma}}\left(\frac{\omega_o f_{oc}}{Y_c}\right)^{\frac{1}{1-\sigma}}\frac{P_c}{\omega_o\tau_{oc}} - \frac{a_{oc}}{\tau_{oc}}\right]^{-1},\tag{2}$$

where $P_c = P_c(\varphi_{oc}^*)$. 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, Moxnes and Opromolla (2010), there is no closed-

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form solution for P_c when the license price is positive. With P_c fixed (i.e., with country o too small to affect prices in country c), it is easy to verify that making the quotas less binding reduces the productivity cutoff for exporting and thereby induces low-productivity firms to enter the export market. This entry drags down the country's unweighted average exporter productivity and raises its average export prices.[7] 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.

A   Quality

Recent research has shown that more productive firms may export at higher prices due to quality.[8] Moreover, as shown in Aw and Roberts (1986) and Feenstra (1988), firms facing a quantity constraint have an incentive to increase product quality. If low prices reflect low quality rather than high productivity, the main prediction of the model above is reversed as quota license fees disproportionately penalize low-quality firms. In that case, quota removal induces entry by low-price, low-quality entrants, and export growth is driven by the entrants rather than incumbents. Given that we infer the extent of misallocation of quota via the contributions of the extensive versus intensive margins, it is important to account for potential contamination of prices with quality. We outline our procedure for doing so in Section C.

II   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).

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[7]Similar outcomes are obtained when the price index is not fixed in our numerical solutions in Section V.

[8]See, for example, Baldwin and Harrigan (2011) and Johnson (2011).

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 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. On January 1, 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, Khandelwal and Schott, 2010). This aspect of the liberalization suggests that the Phase IV quotas were most binding. 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.[9]

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.[10]

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[9]The 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.

[10]The 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, respectively, of China's WTO accession document (WT/ACC/CHN/49). 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 9.2 percent of the product codes. The results of our analysis are unchanged if we exclude these products from the analysis.

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 favoritism 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 (or its predecessor) 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 period, 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).[11] 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, with the result that quotas may not have found their way to agents who valued them the most. We discuss the potential sensitivity of our results to legal or illegal subcontracting in Section V below as well as in our electronic appendix.

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[11]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 of the goods bound by the MFA. Unfortunately, we have been unable to determine the precise criteria the government used to select firms to participate in these auctions.

III Data and Identification Strategy

A Data

Our empirical analysis uses 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").[12] Quantity units are available for 99 percent of observations (and 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 f.o.b. unit values, also referred to as "prices".

Chinese export growth in 2005 is disproportionately large for textile and clothing goods released from quotas. As indicated in the top panel of Table 1, exports bound by the MFA quotas registered a 307 percent increase in export value between 2000 and 2005. By comparison, export growth among similar textile and clothing products not subject quotas is 248 percent. The 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.[13] The message of Table 1 is that quotas were binding under the MFA and exports surged when the quotas were removed.

Our analysis also makes use of China's annual survey of manufacturing, collected by the National Bureau of Statistics (NBS). In principle, these data could be used to identify misallocation of quotas by comparing the total factor productivity (TFP) of firms assigned quotas in 2004 to those which export freely in 2005. Unfortunately, this is not possible. While the NBS does record the major industry of firms and whether or not they export overall, the industries are too coarse to

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[12]We 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.

[13]U.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, Khandelwal and Schott, 2010). The relatively high value growth displayed before 2004 in Table 1 reflects a combination of this growth in quantity as well as sizable increases in prices.

differentiate firms producing quota-bound versus quota-free products. Another potential approach, using the trade data to identify the products firms are producing within the textile and clothing industries, is also not possible given the difficulty of matching firms in the two datasets.[14]

One comparison that is possible using only the NBS is to compare the productivity of exporters within textiles or clothing (industry codes 17 or 18) by ownership type. Figure 1 reports such a comparison for 2005.[15] As indicated in the figure, SOE exporters' distribution lies clearly to the left of the distributions of privately owned exporters. The average (log) TFP for SOEs, domestic firms and foreign firms is 1.57, 3.19, and 2.73, respectively, which implies that SOE exporters are roughly one-fifth to one-third as productive as their private-sector counterparts. 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). Below, we examine reallocation both within and across ownership categories to infer potential misallocation of licenses.

B   Identification Strategy

Our strategy to identify the misallocation of quota licenses exploits the institutional structure of the MFA. We examine China's exports of textile and clothing

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[14]Matching must be done using firm names rather than numerical identifiers. We have succeeded in matching 5,119 (22 percent) of the 2005 quota-bound and quota-free exporters to the NBS production data. These exporters account for 28 percent of total export value of these goods. By ownership type, we match 6 (2), 16 (25) and 49 (64) 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 the electronic appendix, 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.

[15]We calculate a firm f's TFP as $\ln(TFP_f) = va_f - \alpha_f w_f - (1 - \alpha_f)k_f$, where va_f, w_f, and k_f are in logs and denote firm value added, wages and fixed assets (net of depreciation) and α_f is the firm's share of wages in total value added. 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. This approach assumes the revenue-based TFP measures in the figure reveal variation in physical efficiency. Of course, productivity measures constructed from revenue information suffer from well-known biases due to firm-specific price variation that capture demand shocks and/or markups (see De Loecker, Goldberg, Khandelwal and Pavcnik 2012). We are unable to correct for this potential measurement problem because the NBS data do not record firm-specific prices. Nevertheless, the estimates are consistent with well-known inefficiencies of state-run firms. An analogous figure based on labor productivity is similar and reported in our electronic appendix.

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 "quota-bound" product-country pairs, encompass textile and clothing products bound by quotas until 2004. The remaining product-country pairs, referred to as "quota-free", consist of textile and clothing products exported quota-free.

Our analysis is restricted to HS products that are bound by quotas in one market but exported free of quotas in another, so that *every* HS product in our sample is both quota-bound and quota-free depending upon its destination. Shipments of "men's cotton pajamas" (HS 62072100), for example, were subject to a quota in the U.S. and Canada in 2004 but not in the E.U. This restriction controls for underlying trends that are common to both quota-bound and quota-free exports, ensuring that the only difference between them is their coverage under the MFA. Of the 547 products that are subject to a quota by any of the U.S., the E.U. or Canada, 188 are subject to quotas by all three destinations. Removing those products yields a sample of 359 HS categories that meet our restriction.[16]

One test of the validity of our assumption that the quota-free and quota-bound exports in our sample are otherwise similar is that the SOE's share of the two types of exports are statistically equal once quotas are removed. This result is illustrated in Table 2, which reports annual regressions of the quantity share of SOE exports (within each HS-country pair) on a dummy variable indicating the pair was subject to quotas. Prior to 2005, quota-bound exports have a (statistically significant) larger share of SOEs exports, an outcome which we argue below is a key indicator of misallocation. The disappearance of this gap in 2005 strongly suggests that the only underlying difference between the types of exports in terms of SOE ownership is the quota itself. Results are similar if we analyze the export shares of domestic and foreign-owned firms.

Our identification strategy is a straightforward difference-in-differences estimator that compares changes in outcomes among quota-bound and quota-free exports

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[16]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. In an earlier version of this paper (Khandelwal, Schott and Wei, 2011), we demonstrate very similar results to those reported in the next section when the "control" group encompasses a broader classification of textile and clothing HS codes.

in 2005:

$$
\begin{aligned}
\Delta Y_{hct} &= \alpha_0 + \alpha_1 1\{\text{t=2005}\} + \alpha_2 1\{hc \in \text{Quota-Bound}\} \qquad (3) \\
&+ \alpha_3 1\{\text{t=2005}\} \times 1\{hc \in \text{Quota-Bound}\} + \epsilon_{hct},
\end{aligned}
$$

where ΔY_{hct} is the change in some product-country outcome variable, e.g., market share, between years $t-1$ and t and standard errors are clustered at the HS product level. The regression sample includes observations for both $t = 2005$ and $t = 2004$. We refer to the estimated coefficient α_3 as the difference-in-differences estimate: it captures the average difference between ΔY_{hct} in quota-bound exports between 2004-2005 versus 2003-2004 relative to the analogous difference among quota-free exports. This identification strategy controls 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. To gauge whether pre-existing trends are not influencing our results, we also estimate equation (3) with hc fixed effects to account for underlying heterogeneity in trends across product-country pairs. We also estimate a "placebo" specification examining changes between 2003 to 2004 versus 2002 to 2003.

IV   Evidence of Misallocation

The model developed in Section I 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.

A   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 product categories exported by the same firm to the same country in both 2004 and 2005. The extensive margin is comprised of entrants and exiters. Entrants 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. We construct the quantity market share of each margin (m) within each product-country pair (hc) in each year (t) as $\Theta_{hct}^m = \left(\sum_{f \in m} q_{fhct}^m / \sum_m \sum_f q_{fhct}^m \right)$. We estimate 12 regressions (three ownership categories multiplied by four margins) of the form specified in equation (3), where $\Delta Y_{hct} = \Theta_{hct}^m$. Under the auction-allocation scenario presented in Section I, export growth following quota removal should be concentrated among the largest incumbents due to their (presumed) greater productivity. Instead, we find the opposite.

Complete regression results are reported in Table A.1 of our electronic appendix and summarized in Table 3, where estimated differences are in bold if they are statistically significantly different from zero at the 10 percent level. The first column of the top panel of Table 3 reports the difference-in-differences estimate of market share reallocation (α_3 from equation 3). 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 quota-bound) products in 2004 prior to adding a quota-bound product in 2005.[17] Incumbents' market shares decline by an average of 12.2 percentage points across product-destination pairs in the year quotas are removed. This decline is offset (necessarily) by a 12.2 percentage-point average gain by net entrants, for an overall average change of zero. Of this 12.2 percentage-point gain, adders and new exporters contribute 11.6 and 3.7 percent, respectively, while exiters account for -3.1 percent, although this

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[17]A given firm may contribute to both the intensive and "adder" extensive margins if it both continues to export a quota-bound country-product pair between 2004 and 2005 and adds another quota-bound pair during that interval. In 2004, 71 percent of firms export both quota-bound and quota-free categories; these firms represent 92 percent of quota-bound export value.

latter number is not statistically significant. These patterns of adjustment are inconsistent with the auction-allocation model, which implies a disproportionately larger growth in market share among incumbent firms following quota removal. We 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. Furthermore, it is likely more difficult to add a new product-country pair than to expand production of an existing product-country pair. Even if one thought that existing exporters, broadly defined to include "incumbents" and "adders", faced the sharpest capacity constraints, one would then expect new exporters to dominate net entry. In fact, Table 3 demonstrates that reallocation towards new exporters is small.[18]

Columns two to four of Table 3 decompose changes in relative market share for each margin by type of firm ownership. Each row sums to the value in the first column. Three trends stand out. First, as indicated in the final row of these columns, there is a net 14.7 percent reallocation of market share away from SOEs towards privately owned domestic (9.2 percent) and foreign (5.5 percent) entrants. Second, the majority of the decline among in SOEs (10.6 percentage points) occurs among incumbents. Finally, most of the gain in market share (16.3 percentage points) occurs among privately owned domestic and foreign firms.[19] Furthermore, in the electronic appendix, we show that the largest incumbents disproportionately lose the most market share in quota-bound products following the reform.

Together, these patterns suggest that the "excessive" quota enjoyed by some incumbent SOEs in 2004 came at the expense privately owned firms who were shut out of the export market for these products. Moreover, given the large differences in TFP between SOE and private firms (Figure 1), they are a strong indication that quota licenses in 2004 were not held by the most productive firms.

We demonstrate the robustness of these findings in two ways. First, in the middle panel of Table 3 we add a *hc* pair fixed effect to specification (3), which

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[18]We thank one of our referees for making this point.

[19]In 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 the U.S. Office of Textile and Apparel, Système Intégré de Gestion de Licenses, and Foreign Affairs and International Trade Canada, respectively.

yields "within" hc results that control for underlying heterogeneity across product-country pairs. While α_2 is not identified in this specification, the coefficient α_3 captures the average difference in 2005 of quota-bound exports relative to their underlying trend in outcomes. Results are very similar: the major difference with respect to the specification without fixed effects is in column eight where the net change associated with the extensive margin becomes statistically insignificant. Second, our placebo specification in the bottom panel,, reveals no substantial losses among SOE incumbents or gains among private entrants during the "pre"-period, where differences are assessed between 2003 to 2004 versus 2002 to 2003. This placebo test demonstrates that post-quota reallocation does not reflect pre-existing trends.

B Prices

MFA export prices fall substantially when quotas are removed. In sharp contrast to the implications of the auction-allocation model, the majority of this decline is 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 ($\overline{P}_{hct}$) across all firms' log export unit values, $\ln(p_{fhct})$, using their quantity market shares (θ_{fhct}) as weights[20],

$$\bar{P}_{hct} = \sum_f \theta_{fhct} \ln(p_{fhct}). \tag{4}$$

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

$$\Delta \bar{P}_{hct} = \left(\overline{P}_{hct} - \overline{P}_{hct-1} \right). \tag{5}$$

Between 2004 and 2005, quota-bound export prices fall by an average of 0.212 log points across product-country pairs. The analogous change for quota-free exports is an increase of 0.015 log points. The relative price decline for quota-bound

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[20]We 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.

exports is also sharp compared to that group's average 0.070 log point increase in prices between 2003 and 2004. These trends demonstrate that quota removal is associated with substantial price declines.

Figure 2 plots the distribution of incumbents' and entrants' normalized 2005 log export prices against exiters' normalized 2004 log export prices. In both cases the normalization involves subtracting off the corresponding product-country across-year log mean price, $\overline{P}_{hc} = \frac{1}{2}\left(\overline{P}_{hct} + \overline{P}_{hct-1}\right)$. 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 quota-bound exports in 2004 have relatively high prices compared to 2005 entrants. On average, entrants' prices are 0.26 and 0.21 log points lower than incumbents' and exiters' prices, respectively. By comparison, the top and bottom panels of Figure 3 reveal that we do not find a similar ordering of entrants' and exiters' prices either contemporaneously in quota-free exports or in quota-bound exports the year before.

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

$$\Delta\bar{P}_{hct} = \frac{1}{\overline{P}_{hct-1}}\left[\sum_{f\in I}\overline{\theta}_{fhc}\left(\ln(p_{fhct}) - \ln(p_{fhct-1})\right) + \sum_{f\in I}\left(\theta_{fhct} - \theta_{fhct-1}\right)\left(\overline{p}_{fhc} - \overline{P}_{hc}\right)\right]$$

$$(6)$$

$$+ \frac{1}{\overline{P}_{hct-1}}\left[\sum_{f\in N}\theta_{fhct}\left(\ln(p_{fhct}) - \overline{P}_{hc}\right)\right] - \frac{1}{\overline{P}_{hct-1}}\left[\sum_{f\in X}\theta_{fhct-1}\left(\ln(p_{fhct-1}) - \overline{P}_{hc}\right)\right].$$

As above, θ represents quantity-based market share and f, h and c index exporting firms, 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 3.) $\overline{\theta}_{fhc}$ is the average market share of firm f in hc across years, i.e., $\overline{\theta}_{fhc} = \left(\theta_{fhct} + \theta_{fhct-1}\right)/2$. Finally,

$\bar{p}_{fhc} = (\ln p_{fhct} + \ln p_{fhct-1})/2$ 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 quota removal, 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 $\Delta \bar{P}_{hct}$. As discussed in Section I, the within component may register price declines even in the absence of an explicit license fee as the shadow price of the quota constraint falls to zero as quotas are removed.

The second term in square brackets in equation (6) 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 the specification provided in equation (3) to perform an analysis of each of the components of $\Delta \bar{P}_{hct}$. Complete regression results are reported in Table A.2 of our electronic appendix and are summarized in Table 4 using the same format as with market shares in the last section. Here, our difference-in-differences estimate 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.

Two trends stand out. First, as illustrated in the first column of the top panel of the table, the extensive margin accounts for more than half (58 percent) of the 0.206 log point relative decline in quota-bound export prices in 2005. Moreover, most of the price decline associated with incumbents (-0.049 of -0.086 log points) is due to the loss of market share by relatively high-priced firms (the "across" component) versus price declines holding market shares fixed (the "within" component). Along

the extensive margin, the entry of lower-priced firms and the exit of higher-priced firms contribute more or less equally.

Second, echoing the market share results discussed above, the influence of the extensive margin on prices is strongest among privately owned firms. As indicated in columns two through four of the top panel of Table 4, SOEs and domestic firms are responsible for 95 percent of the overall post-quota decline in prices. For SOEs, this change is driven primarily by incumbents, which account for 54 percent (-0.051/-0.095) of the price decline. For domestic firms, however, the decline in prices is concentrated along the extensive margin, with entry and exit accounting for 50 and 28 percent of the decline, respectively. To the extent that lower prices reflect higher productivity (more on this in the next two sections), these trends are inconsistent with post-MFA entry by *lower* productivity firms implied by the auction allocation model.

The middle panel of Table 4 demonstrates that these trends hold within product-country pairs. Likewise, the placebo analysis in the bottom panel reveals no substantial pre-trends in the price movements emphasized in the last paragraph, except perhaps exit by relatively high-priced SOEs.

C   Quality-Adjusted Prices

As noted in Section I, our inferences regarding misallocation from price changes are sensitive to whether prices vary with quality as well as productivity. In a model where high-productivity firms produce goods of higher quality, the contribution of low-priced entrants reported in the previous section might indicate quality down-grading rather than the entry of higher-productivity firms. This issue is addressed in two ways.

First, our discussion thus far has demonstrated significant reallocation of exports from state-owned to non-state-owned exporters as quotas are removed. Given the evidence demonstrating relatively low productivity among SOEs presented above (Figure 1) as well as in the wider literature, this reallocation suggests licenses were misallocated under the quota regime.

Second, we show that the results reported in the last section persist in quality-adjusted prices. Assume consumers' preferences incorporate quality (λ), so the

utility function becomes $U = \left(\int_{\zeta \in \Omega} (\lambda_c(\zeta) q_c(\zeta))^{(\sigma-1)/\sigma} d\zeta \right)^{\sigma/(\sigma-1)}$. In this case, demand is given by $q_c(\varphi) = \lambda_c^{\sigma-1}(\varphi) p_c^{-\sigma}(\varphi) P_c^{\sigma-1} Y_c$. Taking logs, the quality for each firm-product-country-year observation can be estimated as the residual from the following OLS regression with the assumption of a particular value for σ,

$$\ln q_{fhct} + \sigma \ln p_{fhct} = \alpha_h + \alpha_{ct} + \epsilon_{fcht}, \tag{7}$$

where α_{ct} fixed effect collects the destination country's income and price index and the product fixed effect α_h is included because prices and quantities are not necessarily comparable across product categories. We assume $\sigma = 4$, the median elasticity of substitution across textile and clothing products reported by Broda, Greenfield and Weinstein (2006). Imposing this elasticity of substitution across textile and clothing products allows us to avoid having to estimate demand for each good before inferring quality. Estimated quality is $\ln \hat{\lambda} = \hat{\epsilon}_{fhct}/(\sigma - 1)$, and quality-adjusted prices are $\ln p_{fhct} - \ln \hat{\lambda}_{fhct}$. The intuition behind this approach is straightforward: conditional on price, a variety with a higher quantity is assigned higher quality.[21]

The top panel of Table 5 reports a decomposition of quality-adjusted prices analogous to Table 4. Results are qualitatively similar, particularly with respect to the strong influence of the extensive margin in both the overall price decline as well as the price declines by ownership type. Overall, quota removal coincides with a -0.166 log point decline in quality-adjusted prices, versus -0.206 for raw prices. The gap between the two declines indicates that some of the raw price decline is due to quality downgrading, particularly among privately owned domestic entrants, whose contribution declines relative to Table 4.[22] Even so, the influence of the

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[21] Like Khandelwal (2010) and Hallak and Schott (2011), we infer quality from the demand side and do not specify a model that accounts for firm quality choice (e.g., Feenstra and Romalis (2012)). We assume quality is is any attribute that raises consumer demand other than price. We also assume a constant-elasticity-of-substitution demand system, thereby ignoring potential price variation across firms due to markups. Our method differs from the across-product approach developed by Aw and Roberts (1986), Boorstein and Feenstra (1991) and Harrigan and Barrows (2009). In that 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.

[22] As reported in our electronic appendix, difference-in-difference analysis of quality changes

extensive margin rises *vis a vis* Table 4, from 58 to 68 percent. We interpret this 68 percent contribution as strong evidence against the auction-allocation model, and use it to pin down the extent of misallocation in our numerical solutions below.

The remaining panels of Table 5 show that these results are robust to the inclusion of product-country fixed effects, and not evident in the years before the MFA ended.

D   Coarse Computation of Productivity Growth

One coarse approach to estimating the overall productivity gain associated with quota removal is to assign an average TFP to each ownership type using the data reported in Figure 1, and then compute the aggregate change in productivity using the average market share changes by ownership reported in Table 3. Multiplying these through, we find that the reallocation of market shares observed in 2005 implies an increase in exporters' TFP of 21.3 percent.[23] While this estimate ignores heterogeneity in productivity within ownership, it provides a rough sense of the productivity gain from quota removal. Decomposing this gain into the part attributable to misallocation versus the removal of the quota itself requires the counterfactual analysis in the next section.

V   Decomposing Productivity Gains

The model outlined in Section I and described in greater detail in our electronic appendix can be solved numerically to determine how export prices and quantities

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reveals that while there is some evidence of quality downgrading, the magnitudes of this downgrading are generally statistically insignificant. The lack of sharp evidence of quality downgrading is not that surprising given evidence from Khandelwal (2010) and Kugler and Verhoogen (2012) who show that apparel products have a low scope for quality differentiation compared to other products.

[23]As noted in Section A, calculations from the NBS data reveal that the average (log) TFP for SOEs, domestic firms and foreign firms that export textile and clothing is 1.57, 3.19, and 2.73, respectively. From the bottom row in the top panel of Table 3, relative changes in average market shares for SOE, domestic and foreign firms are -0.147, 0.092 and 0.055, respectively. Multiplying through, we attribute a 21.3 percent (= $1.57 \times -0.147 + 3.19 \times 0.092 + 2.73 \times 0.055$). This calculation is based on reallocation across firms and ignores any within-firm improvements due to increases in scale, innovative activity (e.g., Bloom, Draca, and Van Reenen, 2011) or access intermediate inputs (e.g., Goldberg et al, 2010).

as well as exporter productivity evolve as quotas are removed. Using key features of the data reported above, we analyze solutions for three scenarios: no quotas, quotas assigned via auction, and quotas distributed according to "politics". Comparing the first scenario to the other two allows us to quantify the potential productivity loss associated with misallocation.

A   Quota-Free Allocation

We begin by simulating a model in which exports are not subject to quotas in the destination market. We consider one industry and two countries, China and an aggregation of the United States, European Union and Canada (UEC). The parameters of the model are: σ, $L = L_{Chn}, L_{UEC}, G(\varphi), \tau = \{\tau_{Chn,Chn}, \tau_{Chn,UEC}, \tau_{UEC,Chn}, \tau_{UEC,UEC}\}$, $f = \{f_{Chn,Chn}, f_{Chn,UEC}, f_{UEC,Chn}, f_{UEC,UEC}\}$, $\omega = \{\omega_{Chn}, \omega_{UEC}\}$.[24] We impose values for some of these parameters and choose the remaining parameters by matching particular statistics in the data. We assume that the two countries have identical sizes $L_{UEC} = L_{Chn} = 100$.[25] We choose an elasticity of substitution, $\sigma = 4$, that is the median among the apparel and textiles elasticities estimated in Broda, Greenfield and Weinstein (2006). We assume a log normal productivity distribution with mean μ and variance ϑ, $G(\varphi) \sim \ln \mathbb{N}(\mu, \vartheta)$. 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 μ and ϑ, 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.[26] The

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[24] We 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, ($\tau_{Chn,Chn} = \tau_{UEC,UEC} = 1$).

[25] The population of the U.S., Canada and the E.U. (900 million) is relatively close to that of China (1.2 billion).

[26] Forty-four percent of Chinese textile and clothing (Chinese Industrial Classifications 17 and 18) firms export in 2005 (source: China's NBS). The shares of exports accounted for by the 75th,

resulting parameters are $\mu = 1.28$, $\vartheta = 0.54$, $\tau_{Chn,UEC} = 1.80$, $\tau_{UEC,Chn} = 3.55$, $f_{Chn,UEC}/f_{Chn,Chn} = 1.15$ and $f_{UEC,Chn}/f_{UEC,UEC} = 1.15$.[27]

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. In this scenario, the market-share weighted average TFP of exporters is 4.21.

B   Auction Allocation

The solution to the auction-allocation scenario of the model involves finding a common license price that keeps aggregate exports from exceeding the quota. In the data, the median growth of quota-bound exports relative to quota-free exports is 161 percent in 2005. We add the quota restrictiveness implied by this growth rate to the no-quota model and (numerically) solve for the common quota license price that equates demand and supply of quota licenses. As a result, total exports under the no-quota model are 161 percent larger than total exports under auction allocation. As expected, the weighted average productivity of firms is lower in this scenario versus the no-quota scenario, 3.43 versus 4.21. Moreover, in stark contrast to our empirical findings in Tables *4* and 5, *all* of the net price decline associated with the removal of auction-allocated quotas is due to incumbents, as only rela-

90th, 95th, 99th and 99.9th percentiles of these exporters are 0.26, 0.46, 0.59, 0.80, 0.93 and 1, respectively. Eight percent of U.S. firms in the apparel sector (NAICS 315) export in 2002 (source: Bernard et al., 2007). The U.S. market share of Chinese textile and clothing (China Industrial Classification codes 17 and 18) consumption in 2005 is 1.2 percent (source: China's NBS and Chinese customs data). The Chinese market share of U.S. apparel and textile (NAICS codes 313, 314 and 315) consumption in 2005 is 13.1 percent (source: NBER Productivity Database). We use U.S. data on Chinese import penetration and fraction of textile exporters as this information is not available for Canada and the E.U. We use data from 2005 because quotas are not in effect that year.

[27] According the 2005 U.S. tariff schedule and the 2007 China tariff schedule, the median MFN ad valorem equivalent tariff rates for the products in our sample are 8.9 and 12.0 percent, respectively. If we assume the non-tariff component of trade costs (distance plus non-tariff barriers) is twice as high for Chinese exports to the U.S./E.U./Canada than vice versa (for example, eastbound shipping rates from China often exceed westbound rates to China because of the trade imbalance), then implicit U.S./E.U./Canada wages are approximately five times higher than Chinese wages. The NBER Productivity Database indicates an average annual salary of $24,000 in the apparel sector in 2005. The 2005 World Development Indicators database indicates a PPP-adjusted income per capita in China of $4,000 in 2005. This suggests that U.S. apparel wages were roughly six times China's income per capita, close to our the implicit wage ratio.

tively low-productivity firms enter when quotas are removed. The solution for the license price, 0.14, represents an average of 10 percent of the export price across exporters. Because the quota penalizes high-productivity firms disproportionately, the quantity market share of the top 1 percent most productive exporters under auction allocation is approximately half of the analogous share under the no-quota allocation.

C   Political Allocation

The importance of the extensive margin in *observed* price declines, relative to its predicted irrelevance in the auction-allocation model, is strong evidence against the hypothesis that the Chinese government assigned export quotas according to firm efficiency. Quantifying the extent of this misallocation requires comparison of the actual allocation mechanism used by the government to the (counterfactual) auction-allocation mechanism outlined in the previous section. As we have no information on how the government actually allocated quotas, we construct a coarse "political-allocation" scenario designed to match the observed influence of the extensive margin on quality-adjusted price declines.

To keep the analysis simple, we re-assign the market shares derived in the auction-allocation scenario to an alternative set of firms on the basis of a new firm draw, κ, which we interpret as a measure of firms' ability to obtain quota via "political connections". We view this second source of firm heterogeneity as a firm endowment (like φ) and ignore any potential deadweight loss associated with bribery or lobbying (Bhagwati 1982). We assume κ has rank correlation ρ with φ. For a given ρ, we sort firms according to κ and assign the corresponding export share from the auction-allocation solution, firm by firm. That is, the firm with the highest political connection receives the highest market share assigned under auction allocation, and so on. We continue to assume that firms' prices are determined by φ according to equation (1). For values of ρ sufficiently below 1, our procedure assigns the highest market shares to exporters with relatively low φ even though those exporters have relatively high prices. For this reason, removal of the political allocation in the model induces a strong contribution of the extensive margin to overall price declines as quotas are removed, as found in the data.

At $\rho = 1$, ordering firms according to κ and φ are equivalent and prices as well as

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weighted-average productivity under the auction and political allocation scenarios are identical. As ρ falls below 1, productivity under political allocation falls relative to auction allocation, and export prices rise. For each value of ρ, we compute the implied price decline associated with removing quotas by margin of adjustment using the same procedure employed in our empirical analysis (equation 6). We then choose ρ to match the observed 68 percent contribution by the extensive margin in Table 5. This match occurs at $\rho = 0.15$. At this level of ρ, weighted-average productivity is 1.51, versus 3.43 and 4.21 under auction-allocation and no quotas, respectively. This lower productivity has two sources. First, some low-productivity firms that do not get quotas under the auction receive them under political allocation because they have a relatively high κ. Second, the export market shares of some very high productivity firms under political allocation are reduced or set to zero by their low political connection draw, with the result that the market share of the top 1 percent of exports by productivity is far lower than under the auction- and political-allocation scenarios.

D Discussion

Our numerical solutions indicate that productivity growth following quota removal is disproportionately driven by the removal of the quota licensing regime. Indeed, 71 percent ([3.43-1.51]/[4.21-1.51]) of the gain from removing quotas is due to the elimination of misallocated quota licenses versus 29 percent ([4.21-3.43]/[4.21-1.51]) for the removal of the quota itself. Increases in productivity associated with moving from political- to auction-allocation, and from auction-allocation to no-quota, are substantial, at 128 percent and 23 percent, respectively.[28] While there are reasons to be cautious about our numerical estimates of productivity *growth*, our estimate of the substantial *contribution* of eliminating misallocation appears robust.

Intuition for this conclusion is provided in Figure 4. The left panel of this figure plots the ratio of political- to auction-allocation productivity against the

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[28]In results available upon request, we obtain a similar breakdown using a Pareto distribution for firm productivity. Irarrazabal, Moxnes and Opromolla (2010) discuss in detail how gains from liberalization of additive tariffs can be substantially larger than liberalization of ad valorem tariffs.

contribution of the extensive-margin. This ratio declines rapidly due to the implied misallocation: as licenses are assigned to a greater number of low-productivity firms, aggregate productivity declines and net entry plays a more important role as quotas are removed. The right panel of Figure 4 demonstrates the corresponding increase in the contribution of institutional reform to overall productivity growth. In both panels, a dashed vertical line picks out the observed 68 percent contribution of the extensive margin found in Table 5.

The relative flatness of the contribution of institutional reform over a wide range of extensive-margin contributions suggests that our results are robust to potential mis-measurement of the extensive margin. As noted in Section II, our ability to identify the extensive margin is sensitive to unobserved subcontracting: if customs documents do not reveal a difference between quota-holding firms and the ultimate producers of the export, 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. In principle, subcontracting's illegality should minimize its influence on our results, and we document several trends in support of this conclusion in our electronic appendix. Nevertheless, the relationship in the right panel of Figure 4 shows that even if our results overstate extensive-margin activity by a factor of three, embedded institutional reform would still comprise the majority of the overall productivity gain from quota removal. The left-hand panel of the figure, by contrast, demonstrates that the size of these gains would be far lower.

Applying the 71 percent contribution of embedded institutional reform estimated in this section to the back-of-the-envelope productivity gains computed in Section D implies replacing the actual licensing institution with an auction would increase exporters' productivity by 15 percentage points. By way of context, we note that Hsieh and Klenow (2009) calculate TFP gains of 87 percent from removing *all* domestic distortions from Chinese manufacturing in 2005. Given the myriad other distortions that likely exist in Chinese manufacturing, our estimate seems plausible.

VI   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. Numerical solutions of the model used to guide our empirical analysis suggest that removal of the embedded licensing regime can account for a substantial share of the overall productivity gains associated with trade liberalization.

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, Costinot and Rodriguez-Clare, 2012). 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 (Tang and Wei, 2009). We encourage further research in this area.

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Tables and Figures

Table 1: Export Value and Number of Exporters

	Export Value ($Billion)	
	Quota-Free	Quota-Bound
2000	2.4	4.8
2001	3.2	6.2
2002	3.8	6.5
2003	5.3	7.9
2004	6.3	8.9
2005	8.2	19.6
%Growth 2000-5	248	307
Annual %Growth 2000-4	28	17
Annual %Growth 2004-5	29	119

	Number of Exporting Firms	
	Quota-Free	Quota-Bound
2000	3,525	3,536
2001	4,518	4,253
2002	6,469	5,911
2003	8,501	7,793
2004	10,718	9,523
2005	15,756	18,628
%Growth 2000-5	347	427
Annual %Growth 2000-4	32	28
Annual %Growth 2004-5	47	96

Notes: Panels report annual export value and number of exporters by classification. Exports in the 547 HS products are classified as Quota-Free and Quota-Bound if they are or are not subject to quotas in 2004, respectively.

Table 2: SOE Market Share, by Year

	2002	2003	2004	2005
	(1)	(2)	(3)	(4)
Quota-Bound$_{ch}$	0.084 ***	0.089 ***	0.090 ***	-0.020
	0.019	0.019	0.020	0.017
Constant	0.675 ***	0.596 ***	0.534 ***	0.421 ***
	0.013	0.013	0.014	0.012
Observations	932	943	949	1,016
R-squared	0.02	0.02	0.02	0.00

Notes: Table reports regressions of the share of SOE exports in a HS-country pair in the year noted by each column. This table uses the restricted sample of HS codes defined in Section 4.2. The Quota-Bound dummy is a variable that equals one if the export was subject a quota in 2004, and the coefficient is the difference in SOE shares between Quota-Bound and Quota-Free exports. Significance: * 10 percent, ** 5 percent, *** 1 percent.

Table 3: Decomposition of Market Share Changes

Margin	Difference-in-Differences (Quota-Bound vs Quota-Free, 2004-05 vs 2003-04)			
	All	SOE	Domestic	Foreign
Incumbents	**-0.122**	**-0.106**	-0.013	-0.003
Net Entry				
Adders	**0.116**	-0.011	**0.071**	**0.056**
New Exporters	**0.037**	-0.003	**0.035**	0.005
Exiters	-0.031	-0.027	-0.001	-0.003
Total Net Entry	**0.122**	-0.041	**0.105**	**0.058**
Total	0.000	**-0.147**	**0.092**	**0.055**

Margin	Difference-in-Differences, Country-Product FEs (Quota-Bound vs Quota-Free, 2004-05 vs 2003-04)			
	All	SOE	Domestic	Foreign
Incumbents	**-0.124**	**-0.107**	-0.014	-0.003
Net Entry				
Adders	**0.116**	-0.010	**0.073**	**0.053**
New Exporters	**0.038**	-0.003	**0.036**	0.005
Exiters	-0.030	-0.021	0.000	-0.009
Total Net Entry	**0.124**	-0.034	**0.109**	0.049
Total	0.000	**-0.141**	**0.095**	0.046

Margin	Pre-Reform Difference-in-Differences (Quota-Bound vs Quota-Free, 2003-04 vs 2002-03)			
	All	SOE	Domestic	Foreign
Incumbents	-0.016	-0.001	0.006	**-0.021**
Net Entry				
Adders	0.017	0.002	-0.005	0.020
New Exporters	**-0.024**	**-0.010**	-0.013	-0.001
Exiters	0.024	0.024	0.015	-0.015
Total Net Entry	0.016	0.016	-0.003	0.003
Total	0.000	0.015	0.002	-0.018

Notes: Table reports the coefficient α_3 in equation (3), where the dependent variable in each regression is the change in quantity-based market share for each margin-firm ownership type. The regression is run on the restricted sample of HS codes defined in Section 4.2. The top panel reports the relative change in 2004 to 2005 vs 2003 to 2004 quantity-based market share between Quota-Bound versus Quota-Free exports, by margin of adjustment and firm ownership type. The middle panel is analogous to the left panel, but includes country-product pair fixed effects. The bottom panel runs the regression on the pre-reform sample from 2003 to 2004 versus 2002 to 2003. In all panels, rows 2 to 4 sum to row 5, rows 1 and 5 sum to row 6, and the first column is sum of the remaining columns. Standard errors are clustered by HS product. Estimated coefficients are bold if they are statistically significant at the 10 percent level or better.

Table 4: Decomposition of Export Price Changes

Margin	Difference-in-Differences (Quota-Bound vs Quota-Free, 2004-05 vs 2003-04)			
	All	SOE	Domestic	Foreign
Incumbents (I)				
Within	**-0.037**	**-0.023**	-0.009	-0.005
Across	**-0.049**	**-0.028**	**-0.012**	-0.008
Entrant (N)	**-0.069**	-0.021	**-0.050**	0.002
Exiter (X)	**0.051**	0.022	**0.028**	0.000
Net Entry (N-X)	**-0.120**	-0.044	**-0.078**	0.002
Total	**-0.206**	**-0.095**	**-0.100**	-0.012
Extensive Share	0.582	0.459	0.786	-0.167
Margin	Difference-in-Differences, Country-Product FEs (Quota-Bound vs Quota-Free, 2004-05 vs 2003-04)			
	All	SOE	Domestic	Foreign
Incumbents (I)				
Within	**-0.041**	**-0.026**	-0.010	-0.005
Across	**-0.049**	-0.028	**-0.012**	-0.009
Entrant (N)	**-0.075**	-0.024	**-0.046**	-0.005
Exiter (X)	0.055	0.027	0.028	-0.001
Net Entry (N-X)	**-0.130**	-0.051	**-0.074**	-0.005
Total	**-0.221**	**-0.106**	**-0.096**	-0.019
Extensive Share	0.589	0.487	0.769	0.256
Margin	Pre-Reform Difference-in-Differences (Quota-Bound vs Quota-Free, 2003-04 vs 2002-03)			
	All	SOE	Domestic	Foreign
Incumbents (I)				
Within	-0.018	-0.014	-0.004	0.000
Across	0.007	0.007	0.003	-0.003
Entrant (N)	-0.019	-0.003	0.005	**-0.021**
Exiter (X)	0.027	**0.048**	-0.013	-0.008
Net Entry (N-X)	-0.046	-0.051	0.018	-0.013
Total	-0.058	-0.058	0.017	-0.017
Extensive Share	0.801	0.878	1.068	0.804

Notes: Table reports the coefficient α_3 in equation (3), where the dependent variable in each regression is the change in prices for each margin-firm ownership type. Equation (6) explains how each price margin is computed. The regression is run on the restricted sample of HS codes defined in Section 4.2. The top panel reports the relative change in 2004 to 2005 vs 2003 to 2004 between Quota-Bound versus Quota-Free exports, by margin of adjustment and firm ownership type. The middle panel is analogous to the left panel, but includes country-product pair fixed effects. The bottom panel runs the regression on the pre-reform sample from 2003 to 2004 versus 2002 to 2003. In all panels, rows 2 to 4 sum to row 5, rows 1 and 5 sum to row 6, and the first column is sum of the remaining columns. Standard errors are clustered by HS product. Estimated coefficients are bold if they are statistically significant at the 10 percent level or better.

Table 5: Decomposition of Quality-Adjusted Export Price Changes

| | Difference-in-Differences | | | |
| | (Quota-Bound vs Quota-Free, 2004-05 vs 2003-04) | | | |
Margin	All	SOE	Domestic	Foreign
Incumbents (I)				
Within	**-0.055**	**-0.026**	-0.011	**-0.018**
Across	0.001	-0.005	-0.002	0.007
Entrant (N)	**-0.072**	**-0.026**	**-0.029**	**-0.018**
Exiter (X)	**0.040**	**0.032**	0.007	0.000
Net Entry (N-X)	**-0.112**	**-0.058**	**-0.036**	**-0.018**
Total	**-0.166**	**-0.088**	**-0.049**	**-0.028**
Extensive Share	0.675	0.653	0.736	0.639
	Difference-in-Differences, Country-Product FEs			
	(Quota-Bound vs Quota-Free, 2004-05 vs 2003-04)			
Margin	All	SOE	Domestic	Foreign
Incumbents (I)				
Within	**-0.054**	-0.025	-0.011	**-0.018**
Across	0.001	-0.004	-0.002	0.007
Entrant (N)	**-0.080**	-0.027	**-0.031**	**-0.022**
Exiter (X)	**0.048**	**0.036**	0.009	0.003
Net Entry (N-X)	**-0.129**	**-0.064**	**-0.040**	**-0.025**
Total	**-0.182**	**-0.093**	**-0.054**	**-0.036**
Extensive Share	0.708	0.688	0.750	0.698
	Pre-Reform Difference-in-Differences			
	(Quota-Bound vs Quota-Free, 2003-04 vs 2002-03)			
Margin	All	SOE	Domestic	Foreign
Incumbents (I)				
Within	0.018	0.013	-0.005	0.010
Across	**-0.018**	-0.010	-0.001	-0.006
Entrant (N)	0.004	0.005	-0.005	0.004
Exiter (X)	-0.007	-0.004	-0.002	-0.001
Net Entry (N-X)	0.011	0.009	-0.003	0.005
Total	0.012	0.012	-0.008	0.009
Extensive Share	0.932	0.768	0.320	0.581

Notes: Table reports the coefficient α_3 in equation (3), where the dependent variable in each regression is the change in quality-adjusted price for each margin-firm ownership type. Section 5.3 describes how quality-adjusted prices are measured and equation (6) explains how each margin is computed, using quality-adjusted prices instead of prices. The regression is run on the restricted sample of HS codes defined in Section 4.2. The top panel reports the relative change in 2004 to 2005 vs 2003 to 2004 between Quota-Bound versus Quota-Free exports, by margin of adjustment and firm ownership type. The middle panel is analogous to the left panel, but includes country-product pair fixed effects. The bottom panel runs the regression on the pre-reform sample from 2003 to 2004 versus 2002 to 2003. In all panels, rows 2 to 4 sum to row 5, rows 1 and 5 sum to row 6, and the first column is sum of the remaining columns. Standard errors are clustered by HS product. Estimated coefficients are bold if they are statistically significant at the 10 percent level or better.

Figure 1: Textile and Apparel Producers' TFP, 2005

First and ninety-ninth percentiles are dropped from each distribution. Collective firms are excluded.
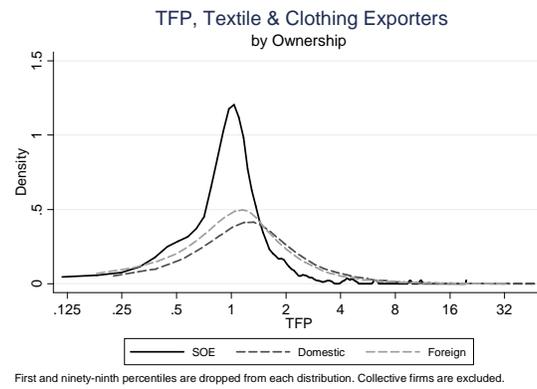
Figure 2: Distribution of Quota-Bound Export Prices, by Margin

First and ninety-ninth percentiles are dropped from each distribution.
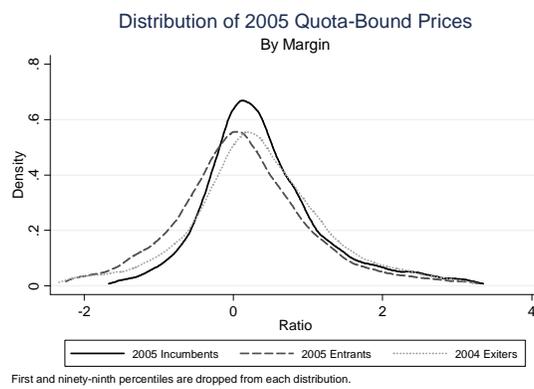
Figure 3: Distribution of Export Prices in Comparator Groups

Distribution of 2004 Quota-Bound Prices
By Margin

Distribution of 2005 Quota-Free Prices
By Margin

2005 Incumbents ———— 2005 Entrants ·········· 2004 Exiters

First and ninety-ninth percentiles are dropped from each distribution.
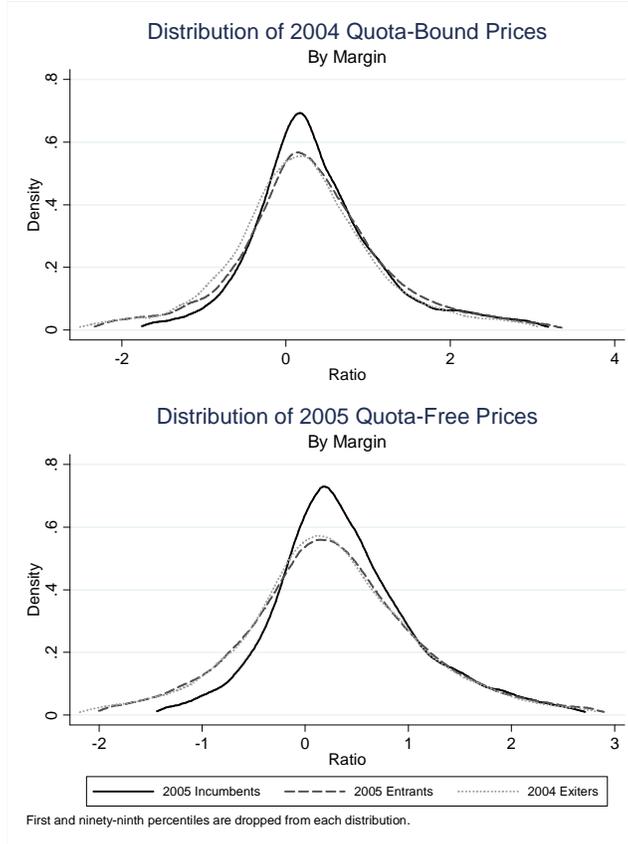
Figure 4: Sensitivity of Inferred Misallocation to Extensive Margin's Contribution to Price Declines After Quotas are Removed
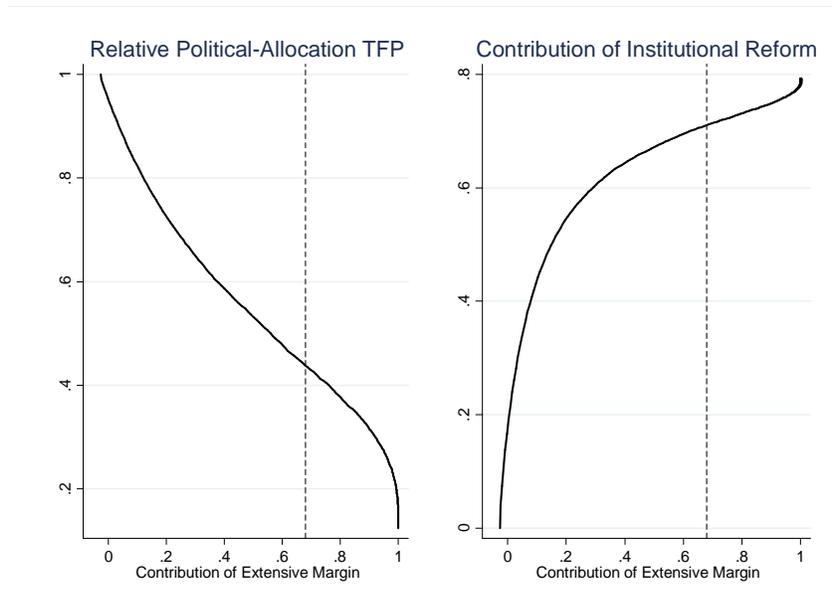
Notes: Left panel displays weighted-average firm TFP under political allocation as a share of weighted-average firm TFP under auction allocation. Right panel traces out the share of overall productivity growth accounted for by institutional reform. Both quantities are plotted against the extensive margin's contribution to the overall price decline when quotas are removed. Dashed vertical lines indicate the observed contribution of the extensive margin from Table 6. Contribution of extensive margin is negative if quota removal induces low-productivity (high-price) firms to enter.

Online Appendix for "Trade Liberalization and Embedded Institutional Reform: Evidence from Chinese Exporters" (Amit K. Khandelwal, Peter K. Schott and Shang-Jin Wei)

This appendix provides further detail about our model and numerical solutions as well as additional empirical results.

A   Model and Numerical Solutions

We consider a single industry and two countries (China and UEC, an aggregation of the United States, E.U. and Canada) in the spirit of Melitz (2003) and Chaney (2008). Embedding a quantitative restriction on exports in this model is akin to including a specific tariff (Irarrazabal, Moxnes and Opromolla 2010). A representative consumer in the export market c maximizes a CES utility function

$$U = \left(\int_{\zeta \in \Omega} [q_c(\zeta)]^{(\sigma-1)/\sigma} \, d\zeta \right)^{\sigma/(\sigma-1)}, \tag{A.1}$$

where $\sigma > 1$ is the constant elasticity of substitution across varieties and ζ indexes varieties.

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

$$p_{oc}(\varphi, a_{oc}) = \frac{\sigma}{\sigma - 1} \omega_o \left(\frac{\tau_{oc}}{\varphi} + a_{oc} \right), \tag{A.2}$$

and export quantity is given by

$$q_{oc}(\varphi, a_{oc}) = \left(\frac{\sigma}{\sigma-1}\omega_o\right)^{-\sigma} \left(\frac{\tau_{oc}}{\varphi} + a_{oc}\right)^{-\sigma} P_c^{\sigma-1} Y_c, \qquad \text{(A.3)}$$

where P_c and Y_c are the price index and expenditure in the destination market, respectively. Here, a_{oc} is license price that equates the aggregate demand for exports with the size of the quota. We assume it is determined (endogenously) by a Walrasian auctioneer.

The 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 $Y_r = \omega_r L_r(1+\pi)$ for $r = \{o, c\}$, where π is the dividend per share of the global fund. The profits for country o's active firms (n_{oc}) selling to market c are $\pi_{oc} = \frac{p_{oc}q_{oc}}{\sigma} - n_{oc}f_{oc}$, so

$$\pi = \frac{\sum_o \sum_c \pi_{oc}}{\omega_o L_o + w_c L_c}. \qquad \text{(A.4)}$$

Firms maximize profits separately to each destination, paying a fixed cost of production in the home profit equation (f_{oo}) and a fixed cost to export abroad (f_{od}) in the exporting profit equation. The marginal exporter earns zero profits and is identified as

$$\varphi_{oc}^* = \left[\left(\frac{\sigma-1}{\sigma}\right)\sigma^{\frac{1}{1-\sigma}}\left(\frac{\omega_o f_{oc}}{Y_d}\right)^{\frac{1}{1-\sigma}} \frac{P_c}{\omega_o \tau_{oc}} - \frac{a_{oc}}{\tau_{oc}}\right]^{-1}, \qquad \text{(A.5)}$$

Given φ_{oc}^*, we can express the price index in destination c as

$$P_c^{1-\sigma} = \sum_r \omega_r L_r \int_{\varphi_{rc}^*}^{\infty} p_{rc}(\varphi, a_{rc})^{1-\sigma} dG(\varphi)\varphi. \qquad \text{(A.6)}$$

Since we assume that only the origin country faces quotas in the export market, we set $a_{cc} = a_{oo} = a_{co} = 0$. Because there is no closed form solution to the price index when $a_{oc} > 0$, the model cannot be solved analytically.

Our numerical solution modifies the algorithm described in Irarrazabal, Moxnes and Opromolla (2010) to account for an endogenous license price. Given the particular parameters noted in the main text (also described in the next paragraph), we solve for all endogenous variables of the model: $\varphi^* = \{\varphi_{Chn,Chn}^*, \varphi_{Chn,UEC}^*, \varphi_{UEC,Chn}^*, \varphi_{UEC,UEC}^*\}$,

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$P = \{P_{Chn}, P_{UEC}\}$, $Y = \{Y_{Chn}, Y_{UEC}\}$, π and $a_{Chn,UEC}$. For our solution to the no quota scenario, we set $a_{Chn,UEC} = 0$. For the auction-allocation scenario, we solve for the license price given the observed quota restrictiveness.

The parameters of the model are: σ, $L = L_{Chn}, L_{UEC}$, $G(\varphi) \sim \ln \mathbb{N}(\mu, \vartheta)$, $\tau = \{\tau_{Chn,Chn}, \tau_{Chn,UEC}, \tau_{UEC,Chn}, \tau_{UEC,UEC}\}$, $f = \{f_{Chn,Chn}, f_{Chn,UEC}, f_{UEC,Chn}, f_{UEC,UEC}\}$, $\omega = \{\omega_{Chn}, \omega_{UEC}\}$. We jointly choose the mean and standard deviation of the log normal firm productivity distribution, 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: a) the 75th, 90th, 95th, 99th and 99.9th percentiles of the distribution of export shares among Chinese textile and clothing exporters, b) the share of Chinese textile and clothing producers that export, c) the share of U.S. textile and clothing producers that export and, d) the Chinese and U.S. market shares of U.S. and Chinese textile and clothing consumption in 2005. China's NBS production data reports that 44 percent of Chinese firms in the textile and clothing sectors (Chinese Industrial Classifications 17 and 18) exported in 2005. These share of 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}. Bernard et al. (2007) report that 8 percent of U.S. firms in the textile and clothing sectors (NAICS 315) exported in 2002. According to textile and clothing production and trade data in the Chinese production and customs data, the U.S. market share of Chinese textile and clothing 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. With the exception of the share of U.S. textile firms that export, all data are from 2005 because that is the first post-quota year. 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 United States; 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.

The Matlab code used to generate our solutions is a modified version of the code used in Irarrazabal, Moxnes and Opromolla (2010), graciously provided by

Andreas Moxnes. It is posted along with this electronic appendix. It contains the following algorithm, where superscripts denote the iteration round. Given a draw of one million firm productivities from the log normal distribution described in the main text:

1. Choose a starting value for the license price a_{oc}^0. (In the "no quota" equilibrium, we set $a_{oc}^0 = 0$.)

2. Choose a starting value for the price indexes, P^0.

3. Simultaneously solve for the dividend per share in equation (A.4) and the cutoffs φ^* in equation (A.5). This involves solving five unknowns with five equations. First choose a candidate π and then compute the cutoffs in (A.5). 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.6).

5. Iterate over steps 3 and 4. The equilibrium values of $\{\varphi^*, P\}$ are found when $\|P^b - P^{b-1}\|$ 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 UEC. In the "auction allocation" equilibrium, continue to step 6.

6. In order to match the data, aggregate exports from China to UEC under "no quota" should be 161 percent higher than aggregate exports under the "auction allocation." Iterate on steps 1-5 until this ratio is achieved.

B Additional Empirical Results

A Regressions

Tables A.1, A.2 and A.3 contain the underlying regression output for the results summarized in Tables 2, 4 and 5.

B   Additional Figures

B.1   Labor Productivity

Figure A.1 reports the distribution of labor productivity of textile and clothing exporters in 2005, by ownership, from the NBS production data. Labor productivity is defined as value added per worker. The low productivity of SOEs relative to their non-state counterparts is consistent with the TFP measures in the text.

B.2   Changes in Incumbent Market Share

Under the auction-allocation scenario presented in Section I, export growth following quota removal should be concentrated among the largest incumbents due to their (presumed) greater productivity. Instead, we find the opposite. Figure A.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 quota-bound exports than quota-free exports, and most severe for SOEs within quota-bound. This result provides further indication that SOEs received excessive allocations under quotas.

B.3   Changes in Average Prices

Figure A.3 displays the mean of $\Delta \bar{P}_{hct}$ across all product-country pairs in quota-bound and quota-free exports for 2003-04 and 2004-05. Between 2004 and 2005, quota-bound export prices fall an average of 0.212 log points across product-country pairs. The analogous change for quota-free exports is an increase of 0.015 log points. Average prices for quota-bound and quota-free exports increased 0.070 and 0.097 log points between 2003 and 2004, respectively.

B.4   Changes in Quality

Table A.4 decomposes quality changes by margin of adjustment and ownership type using the same format as previous decompositions (Table A.5 contains the

underlying regression output). The difference-in-differences results in the top panel indicate an average relative decline in quality among quota-bound exports of 4.1 percent. These declines, however, are not statistically significant. Subtracting the quality changes in Table A.4 from their corresponding price changes in Table 4 yields the quality-adjusted price changes reported in Table 5.

C   Subcontracting

A   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.

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 17 in Section A, we find that *new* quota-bound 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 quota-bound exit rates are relatively low compared

with quota-free exit rates across all ownership types (Table 3).[29]

Third, we find that 86 percent of the quota-holding 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 quota-bound markets 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 quota-bound goods but self-produce output of similar goods for exports to other destinations.[30]

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 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.[31] Table A.6 compares the relative contribution of the extensive margin in quota-bound versus quota-free exports for processed versus all exports. We find that quota-bound 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.

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[29]While 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.

[30]As discussed in Section II, 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.

[31]We 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.

B 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, Khandelwal and Wei (2011) as firms with the words "importer", "exporter" or "trader" in their title, in quota-bound versus quota-free 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, Khandelwal and Wei, 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 output than exports. Indeed, according to our classification, trading companies account for 48 and 46 percent of quota-free and quota-bound 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 ex-

porters 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.

Online Appendix References

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3. Irarrazabal, Alfonso, Andreas Moxnes and Luca David Opromolla (2010), "The Tip of the Iceberg: Modeling Trade Costs and Implications for Intra-Industry Reallocation", mimeo, Dartmouth College.
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Online Appendix Tables and Figures

Table A.1: Regression Output for Table 3

Top Panel

	Incumbent				Exiter				Adder				New Exporter			
	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign
$1(2005)_t$	-0.052	-0.029	-0.012	-0.011	0.030	0.060	-0.026	-0.003	0.047	-0.041	0.066	0.021	-0.025	-0.007	-0.018	0.000
	0.017	0.014	0.008	0.008	0.016	0.017	0.012	0.010	0.015	0.013	0.012	0.010	0.008	0.003	0.007	0.002
$1(\text{Quota-Bound})_{ch}$	0.006	0.011	0.001	-0.005	-0.038	-0.059	0.010	0.011	0.049	0.051	-0.004	0.003	-0.018	0.002	-0.017	-0.003
	0.015	0.013	0.007	0.006	0.019	0.019	0.013	0.009	0.018	0.017	0.012	0.010	0.008	0.004	0.008	0.002
$\times\, 1(2005)_t$	-0.122	-0.106	-0.013	-0.003	-0.031	-0.027	-0.001	-0.003	0.116	-0.011	0.071	0.056	0.037	-0.003	0.035	0.005
	0.024	0.021	0.011	0.010	0.023	0.024	0.018	0.013	0.020	0.021	0.018	0.013	0.010	0.004	0.010	0.003
Constant	-0.040	-0.037	-0.005	0.002	-0.458	-0.282	-0.118	-0.058	0.418	0.235	0.122	0.061	0.080	0.010	0.058	0.012
	0.010	0.009	0.005	0.003	0.016	0.014	0.009	0.007	0.015	0.013	0.009	0.007	0.006	0.003	0.005	0.002
Observations	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830
R-squared	0.07	0.05	0.01	0.00	0.01	0.02	0.00	0.00	0.06	0.02	0.07	0.04	0.01	0.01	0.01	0.00

Middle Panel

	Incumbent				Exiter				Adder				New Exporter			
	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign
$1(2005)_t$	-0.056	-0.031	-0.013	-0.012	0.043	0.068	-0.025	0.000	0.042	-0.046	0.064	0.023	-0.029	-0.007	-0.023	0.000
	0.024	0.020	0.012	0.011	0.022	0.023	0.017	0.014	0.021	0.019	0.017	0.014	0.011	0.004	0.009	0.004
$1(\text{Quota-Bound})_{ch} \times 1(2005)_t$	-0.124	-0.107	-0.014	-0.003	-0.030	-0.021	0.000	-0.009	0.116	-0.010	0.073	0.053	0.038	-0.003	0.036	0.005
	0.035	0.030	0.016	0.015	0.031	0.033	0.025	0.018	0.028	0.028	0.025	0.019	0.015	0.006	0.013	0.005
Constant	-0.035	-0.031	-0.004	0.000	-0.483	-0.316	-0.114	-0.053	0.445	0.262	0.121	0.062	0.073	0.011	0.052	0.010
	0.010	0.008	0.004	0.004	0.009	0.009	0.006	0.004	0.009	0.008	0.007	0.005	0.004	0.001	0.004	0.001
Observations	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830
R-squared	0.51	0.51	0.49	0.44	0.75	0.65	0.59	0.56	0.76	0.67	0.63	0.62	0.60	0.50	0.63	0.52

Bottom Panel

	Incumbent				Exiter				Adder				New Exporter			
	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign
$1(2004)_t$	0.037	0.027	-0.007	0.016	-0.018	0.024	-0.039	-0.003	-0.043	-0.048	0.012	-0.006	0.023	-0.001	0.025	0.000
	0.016	0.014	0.007	0.006	0.016	0.016	0.012	0.009	0.015	0.015	0.011	0.010	0.007	0.003	0.006	0.003
$1(\text{Quota-Bound})_{ch}$	0.023	0.012	-0.005	0.016	-0.061	-0.083	-0.005	0.026	0.032	0.049	0.001	-0.018	0.007	0.012	-0.004	-0.001
	0.017	0.016	0.006	0.006	0.021	0.020	0.011	0.008	0.021	0.019	0.013	0.010	0.007	0.004	0.005	0.003
$\times\, 1(2004)_t$	-0.016	-0.001	0.006	-0.021	0.024	0.024	0.015	-0.015	0.017	0.002	-0.005	0.020	-0.024	-0.010	-0.013	-0.001
	0.025	0.022	0.009	0.010	0.022	0.024	0.016	0.012	0.022	0.022	0.015	0.014	0.011	0.006	0.010	0.003
Constant	-0.077	-0.064	0.002	-0.014	-0.441	-0.306	-0.079	-0.055	0.461	0.283	0.111	0.068	0.056	0.012	0.033	0.011
	0.011	0.010	0.005	0.004	0.016	0.014	0.008	0.007	0.015	0.013	0.008	0.008	0.004	0.001	0.003	0.002
Observations	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786
R-squared	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.00

Notes: This table displays the full regressions of equation (3) for Table 3, which reports the difference-in-differences coefficient on $1(\text{Quota-Bound})_{ch} \times 1(2005)_t$ for the changes in market shares. All regressions are run on the restricted sample of HS codes defined in Section 4.2. The top panel is the baseline specification that corresponds to the left panel of Table 3. The middle panel includes country-product pair fixed effects in the estimation. The bottom panel is run on the pre-reform years (2002-2004). Standard errors are adjusted for clustering at the eight-digit HS level.

Table A.2: Regression Output for Table 4

Top panel

	Incumbent - Within				Incumbent - Across				Entrant				Exiter				Total Change			
	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign
$1(2005)_t$	-0.001	-0.004	0.004	-0.001	-0.001	-0.010	0.002	0.008	-0.038	-0.013	-0.012	-0.013	0.033	0.031	-0.006	0.009	-0.073	-0.058	0.000	-0.014
	(0.008)	(0.005)	(0.006)	(0.003)	(0.010)	(0.009)	(0.003)	(0.004)	(0.018)	(0.013)	(0.008)	(0.006)	(0.016)	(0.012)	(0.008)	(0.005)	(0.039)	(0.028)	(0.017)	(0.010)
$1(\text{Quota-Bound})_{ch}$	-0.006	-0.004	-0.002	0.001	-0.002	-0.004	0.002	0.000	-0.011	-0.002	0.007	-0.016	0.004	0.015	-0.006	-0.005	-0.023	-0.026	0.012	-0.010
	(0.010)	(0.007)	(0.005)	(0.003)	(0.010)	(0.009)	(0.003)	(0.004)	(0.017)	(0.015)	(0.009)	(0.007)	(0.016)	(0.013)	(0.008)	(0.006)	(0.037)	(0.029)	(0.014)	(0.012)
$\times 1(2005)_t$	-0.037	-0.023	-0.009	-0.005	-0.049	-0.028	-0.012	-0.008	-0.069	-0.021	-0.050	0.002	0.051	0.022	0.028	0.000	-0.206	-0.095	-0.100	-0.012
	(0.013)	(0.009)	(0.007)	(0.004)	(0.014)	(0.012)	(0.005)	(0.006)	(0.026)	(0.018)	(0.015)	(0.010)	(0.025)	(0.019)	(0.013)	(0.009)	(0.057)	(0.041)	(0.026)	(0.018)
Constant	0.024	0.016	0.004	0.004	0.000	0.004	-0.001	-0.003	0.004	0.005	-0.011	0.010	-0.063	-0.036	-0.022	-0.005	0.091	0.062	0.014	0.015
	(0.006)	(0.003)	(0.004)	(0.002)	(0.007)	(0.007)	(0.002)	(0.002)	(0.012)	(0.010)	(0.006)	(0.005)	(0.011)	(0.008)	(0.006)	(0.004)	(0.025)	(0.019)	(0.010)	(0.007)
Observations	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830
R-squared	0.02	0.02	0.00	0.00	0.02	0.02	0.01	0.00	0.03	0.01	0.03	0.01	0.02	0.00	0.00	0.00	0.04	0.04	0.01	0.01

Middle panel

	Incumbent - Within				Incumbent - Across				Entrant				Exiter				Total Change			
	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign
$1(2005)_t$	0.000	-0.004	0.005	-0.001	-0.001	-0.011	0.002	0.008	-0.037	-0.012	-0.017	-0.009	0.031	0.030	-0.007	0.008	-0.070	-0.056	-0.004	-0.010
	(0.012)	(0.007)	(0.008)	(0.005)	(0.014)	(0.012)	(0.005)	(0.006)	(0.025)	(0.019)	(0.012)	(0.008)	(0.023)	(0.017)	(0.011)	(0.008)	(0.056)	(0.040)	(0.024)	(0.015)
$1(\text{Quota-Bound})_{ch} \times 1(2005)_t$	-0.041	-0.026	-0.010	-0.005	-0.049	-0.028	-0.012	-0.009	-0.075	-0.024	-0.046	-0.005	0.055	0.027	0.028	-0.001	-0.221	-0.106	-0.096	-0.019
	(0.019)	(0.014)	(0.010)	(0.006)	(0.020)	(0.017)	(0.007)	(0.008)	(0.037)	(0.027)	(0.021)	(0.013)	(0.035)	(0.028)	(0.018)	(0.013)	(0.082)	(0.060)	(0.037)	(0.025)
Constant	0.022	0.015	0.002	0.005	-0.001	0.003	0.000	-0.003	0.000	0.004	-0.006	0.002	-0.061	-0.030	-0.025	-0.007	0.082	0.051	0.021	0.010
	(0.005)	(0.004)	(0.003)	(0.002)	(0.005)	(0.005)	(0.002)	(0.002)	(0.011)	(0.007)	(0.005)	(0.004)	(0.009)	(0.007)	(0.004)	(0.003)	(0.022)	(0.015)	(0.009)	(0.007)
Observations	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830
R-squared	0.46	0.51	0.32	0.49	0.45	0.46	0.49	0.44	0.40	0.42	0.52	0.53	0.45	0.47	0.36	0.46	0.37	0.34	0.41	0.36

Bottom panel

	Incumbent - Within				Incumbent - Across				Entrant				Exiter				Total Change			
	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign
$1(2004)_t$	0.019	0.013	0.003	0.003	0.002	0.009	-0.005	-0.001	0.022	0.006	0.006	0.010	-0.033	-0.026	-0.008	0.001	0.077	0.054	0.013	0.011
	(0.008)	(0.006)	(0.004)	(0.003)	(0.009)	(0.009)	(0.003)	(0.003)	(0.017)	(0.013)	(0.008)	(0.007)	(0.015)	(0.012)	(0.007)	(0.005)	(0.035)	(0.026)	(0.015)	(0.011)
$1(\text{Quota-Bound})_{ch}$	0.012	0.009	0.002	0.001	-0.009	-0.011	-0.001	0.003	0.008	0.001	0.002	0.005	-0.023	-0.033	0.007	0.003	0.034	0.032	-0.005	0.007
	(0.009)	(0.007)	(0.002)	(0.004)	(0.010)	(0.008)	(0.002)	(0.004)	(0.019)	(0.014)	(0.010)	(0.008)	(0.018)	(0.015)	(0.007)	(0.004)	(0.038)	(0.027)	(0.014)	(0.011)
$\times 1(2004)_t$	-0.018	-0.014	-0.004	0.000	0.007	0.007	0.003	-0.003	-0.019	-0.003	0.005	-0.021	0.027	0.048	-0.013	-0.008	-0.058	-0.058	0.017	-0.017
	(0.013)	(0.010)	(0.005)	(0.005)	(0.014)	(0.012)	(0.004)	(0.005)	(0.028)	(0.021)	(0.013)	(0.011)	(0.027)	(0.022)	(0.011)	(0.008)	(0.059)	(0.044)	(0.022)	(0.019)
Constant	0.005	0.003	0.000	0.001	-0.003	-0.004	0.004	-0.002	-0.018	-0.001	-0.017	0.000	-0.030	-0.010	-0.014	-0.005	0.014	0.008	0.001	0.005
	(0.006)	(0.005)	(0.002)	(0.002)	(0.006)	(0.005)	(0.002)	(0.002)	(0.010)	(0.008)	(0.005)	(0.004)	(0.009)	(0.007)	(0.004)	(0.004)	(0.020)	(0.015)	(0.008)	(0.007)
Observations	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786
R-squared	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Notes: This table displays the full regressions of equation (3) for Table 4, which reports the difference-in-differences coefficient on $1(\text{Quota-Bound})_{ch} \times 1(2005)_t$ for the changes in prices defined in equation (6). All regressions are run on the restricted sample of HS codes defined in Section 4.2. The top panel is the baseline specification that corresponds to the left panel of Table 4. The middle panel includes country-product pair fixed effects in the estimation. The bottom panel is run on the pre-reform years (2002-2004). Standard errors are adjusted for clustering at the eight-digit HS level.

Table A.3: Regression Output for Table 5

Top panel

	Incumbent - Within				Incumbent - Across				Entrant				Exiter				Total Change			
	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign
1(2005)$_t$	-0.078 (0.010)	-0.050 (0.008)	-0.019 (0.004)	-0.009 (0.005)	0.000 (0.006)	0.004 (0.005)	-0.001 (0.002)	-0.003 (0.003)	-0.043 (0.012)	-0.021 (0.006)	-0.013 (0.007)	-0.008 (0.005)	0.036 (-0.012)	0.017 (-0.008)	0.015 (-0.005)	0.004 (-0.004)	-0.156 (0.028)	-0.084 (0.016)	-0.048 (0.012)	-0.024 (0.010)
1(Quota-Bound)$_{ch}$	0.011 (0.012)	0.001 (0.008)	0.002 (0.006)	0.008 (0.005)	-0.013 (0.007)	-0.003 (0.005)	-0.003 (0.002)	-0.007 (0.004)	-0.016 (0.011)	-0.007 (0.008)	-0.011 (0.006)	0.003 (0.003)	-0.009 (-0.011)	-0.005 (-0.008)	-0.008 (-0.004)	0.004 (-0.004)	-0.009 (0.025)	-0.004 (0.018)	-0.005 (0.010)	0.000 (0.008)
x 1(2005)$_t$	-0.055 (0.016)	-0.026 (0.012)	-0.011 (0.007)	-0.018 (0.007)	0.001 (0.009)	-0.005 (0.007)	-0.002 (0.003)	0.007 (0.005)	-0.072 (0.019)	-0.026 (0.012)	-0.029 (0.011)	-0.018 (0.006)	0.040 (-0.017)	0.032 (-0.013)	0.007 (-0.007)	0.000 (-0.005)	-0.166 (0.042)	-0.088 (0.029)	-0.049 (0.017)	-0.028 (0.012)
Constant	0.032 (0.007)	0.028 (0.005)	0.005 (0.003)	-0.001 (0.003)	-0.003 (0.004)	-0.007 (0.003)	0.001 (0.001)	0.004 (0.002)	0.057 (0.007)	0.029 (0.004)	0.026 (0.004)	0.003 (0.003)	0.048 (-0.007)	0.026 (-0.005)	0.018 (-0.003)	0.005 (-0.004)	0.038 (0.016)	0.024 (0.010)	0.014 (0.007)	0.000 (0.007)
Observations	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830
R-squared	0.09	0.06	0.03	0.01	0.00	0.00	0.00	0.00	0.07	0.03	0.03	0.02	0.03	0.02	0.01	0.00	0.09	0.06	0.03	0.01

Middle panel

	Incumbent - Within				Incumbent - Across				Entrant				Exiter				Total Change			
	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign
1(2005)$_t$	-0.078 (0.015)	-0.049 (0.011)	-0.020 (0.006)	-0.009 (0.007)	0.001 (0.009)	0.004 (0.007)	-0.001 (0.003)	-0.003 (0.004)	-0.036 (0.018)	-0.020 (0.009)	-0.008 (0.010)	-0.008 (0.007)	0.031 (-0.017)	0.011 (-0.011)	0.015 (-0.007)	0.005 (-0.006)	-0.144 (0.041)	-0.076 (0.023)	-0.044 (0.018)	-0.025 (0.015)
1(Quota-Bound)$_{ch}$ x 1(2005)$_t$	-0.054 (0.023)	-0.025 (0.017)	-0.011 (0.010)	-0.018 (0.010)	0.001 (0.014)	-0.004 (0.011)	-0.002 (0.005)	0.007 (0.007)	-0.080 (0.027)	-0.027 (0.017)	-0.031 (0.015)	-0.022 (0.009)	0.048 (-0.024)	0.036 (-0.019)	0.009 (-0.010)	0.003 (-0.007)	-0.182 (0.060)	-0.093 (0.042)	-0.054 (0.025)	-0.036 (0.017)
Constant	0.037 (0.006)	0.028 (0.005)	0.006 (0.003)	0.003 (0.003)	-0.009 (0.004)	-0.009 (0.003)	-0.001 (0.001)	0.000 (0.002)	0.048 (0.007)	0.025 (0.004)	0.018 (0.004)	0.005 (0.003)	0.044 (-0.006)	0.025 (-0.004)	0.013 (-0.003)	0.005 (-0.002)	0.031 (0.016)	0.019 (0.009)	0.010 (0.007)	0.002 (0.005)
Observations	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830
R-squared	0.57	0.55	0.50	0.56	0.48	0.48	0.48	0.45	0.48	0.47	0.58	0.54	0.54	0.50	0.49	0.54	0.44	0.39	0.47	0.47

Bottom panel

	Incumbent - Within				Incumbent - Across				Entrant				Exiter				Total Change			
	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign
1(2004)$_t$	0.032 (0.010)	0.019 (0.008)	0.013 (0.004)	0.000 (0.005)	0.008 (0.006)	0.003 (0.005)	0.001 (0.002)	0.004 (0.003)	0.021 (0.012)	0.012 (0.007)	0.010 (0.006)	-0.001 (0.006)	-0.005 (-0.011)	-0.015 (-0.008)	0.007 (-0.004)	0.003 (-0.004)	0.066 (0.026)	0.049 (0.016)	0.016 (0.009)	0.001 (0.010)
1(Quota-Bound)$_{ch}$	-0.007 (0.010)	-0.012 (0.009)	0.007 (0.003)	-0.002 (0.004)	0.004 (0.006)	0.008 (0.005)	-0.002 (0.002)	-0.001 (0.002)	-0.020 (0.012)	-0.012 (0.008)	-0.006 (0.006)	-0.001 (0.005)	-0.002 (-0.012)	-0.001 (-0.010)	-0.005 (-0.004)	0.005 (-0.003)	-0.021 (0.026)	-0.016 (0.019)	0.003 (0.008)	-0.009 (0.008)
x 1(2004)$_t$	0.018 (0.016)	0.013 (0.013)	-0.005 (0.007)	0.010 (0.008)	-0.018 (0.010)	-0.010 (0.008)	-0.001 (0.003)	-0.006 (0.005)	0.004 (0.018)	0.005 (0.012)	-0.005 (0.009)	0.004 (0.007)	-0.007 (-0.018)	-0.004 (-0.014)	-0.002 (-0.006)	-0.001 (-0.006)	0.012 (0.041)	0.012 (0.029)	-0.008 (0.014)	0.009 (0.013)
Constant	0.000 (0.007)	0.009 (0.006)	-0.008 (0.002)	-0.002 (0.003)	-0.011 (0.004)	-0.010 (0.003)	-0.001 (0.001)	0.000 (0.002)	0.036 (0.008)	0.016 (0.005)	0.016 (0.004)	0.004 (0.004)	0.053 (-0.007)	0.040 (-0.007)	0.010 (-0.002)	0.002 (-0.002)	-0.028 (0.017)	-0.025 (0.012)	-0.003 (0.006)	0.000 (0.005)
Observations	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786
R-squared	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00

Notes: This table displays the full regressions of equation (3) for Table 5, which reports the difference-in-differences coefficient on 1(Quota-Bound)$_{ch}$ x 1(2005)$_t$ for the changes in quality-adjusted prices defined in Section 5.3 All regressions are run on the restricted sample of HS codes defined in Section 4.2. The top panel is the baseline specification that corresponds to the left panel of Table 5. The middle panel includes country-product pair fixed effects in the estimation. The bottom panel is run on the pre-reform years (2002-2004). Standard errors are adjusted for clustering at the eight-digit HS level.

Table A.4: Decomposition of Absolute and Relative Changes in MFA Quality

| | Difference-in-Differences | | | |
| | (Quota-Bound vs Quota-Free, 2004-05 vs 2003-04) | | | |
Margin	All	SOE	Domestic	Foreign
Incumbents (I)				
Within	0.017	0.003	0.002	0.012
Across	**-0.050**	-0.024	**-0.010**	**-0.016**
Entrant (N)	0.003	0.004	-0.021	**0.020**
Exiter (X)	0.011	-0.010	0.021	-0.001
Net Entry (N-X)	-0.008	0.014	-0.042	0.020
Total	-0.041	-0.007	-0.051	0.017
Extensive Share	0.199	-2.085	0.834	1.198
	Difference-in-Differences, Country-Product FEs			
	(Quota-Bound vs Quota-Free, 2004-05 vs 2003-04)			
Margin	All	SOE	Domestic	Foreign
Incumbents (I)				
Within	0.013	-0.002	0.001	0.013
Across	**-0.050**	-0.024	-0.010	-0.016
Entrant (N)	0.005	0.003	-0.015	0.017
Exiter (X)	0.006	-0.009	0.019	-0.003
Net Entry (N-X)	-0.001	0.012	-0.033	0.020
Total	-0.039	-0.013	-0.042	0.017
Extensive Share	0.029	-0.928	0.793	1.207
	Pre-Reform Difference-in-Differences			
	(Quota-Bound vs Quota-Free, 2003-04 vs 2002-03)			
Margin	All	SOE	Domestic	Foreign
Incumbents (I)				
Within	**-0.037**	-0.027	0.001	-0.010
Across	0.024	0.017	0.004	0.004
Entrant (N)	-0.024	-0.008	0.010	**-0.025**
Exiter (X)	0.034	**0.051**	-0.011	-0.007
Net Entry (N-X)	-0.058	-0.060	0.021	-0.018
Total	-0.070	-0.070	0.025	-0.025
Extensive Share	0.824	0.860	0.827	0.728

Notes: Table reports the coefficient α_3 in equation (3), where the dependent variable in each regression is the change in quality for each margin-firm ownership type. Section 5.3 describes how quality is measured and equation (6) explains how each margin is computed, using quality instead of prices. The regression is run on the restricted sample of HS codes defined in Section 4.2. The top panel reports the relative change in 2004 to 2005 vs 2003 to 2004 between Quota-Bound versus Quota-Free exports, by margin of adjustment and firm ownership type. The middle panel is analogous to the left panel, but includes country-product pair fixed effects. The bottom panel runs the regression on the pre-reform sample from 2003 to 2004 versus 2002 to 2003. In all panels, rows 2 to 4 sum to row 5, rows 1 and 5 sum to row 6, and the first column is sum of the remaining columns. Standard errors are clustered by HS product. Estimated coefficients are bold if they are statistically significant at the 10 percent level or better.

Table A.5: Regression Output for Table A.4

	Incumbent - Within				Incumbent - Across				Entrant				Exiter				Total Change			
	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign
$1\{2005\}_t$	0.076	0.045	0.023	0.008	-0.001	-0.014	0.002	0.011	0.005	0.009	0.001	-0.004	-0.003	0.014	-0.021	0.004	0.083	0.026	0.048	0.009
	0.013	0.008	0.007	0.007	0.013	0.011	0.004	0.005	0.024	0.015	0.013	0.008	0.021	0.014	0.011	0.008	0.052	0.033	0.023	0.017
$1\{$Quota-Bound$\}_{ch}$	-0.017	-0.005	-0.004	-0.007	0.011	-0.002	0.005	0.008	0.005	0.005	0.018	-0.019	0.013	0.020	0.002	-0.008	-0.014	-0.022	0.017	-0.010
	0.015	0.010	0.009	0.006	0.013	0.011	0.004	0.006	0.022	0.018	0.012	0.009	0.021	0.016	0.010	0.008	0.047	0.035	0.019	0.015
x $1\{2005\}_t$	0.017	0.003	0.002	0.012	-0.050	-0.024	-0.010	-0.016	0.003	0.004	-0.021	0.020	0.011	-0.010	0.021	-0.001	-0.041	-0.007	-0.051	0.017
	0.021	0.015	0.011	0.008	0.018	0.015	0.006	0.008	0.034	0.022	0.020	0.011	0.032	0.024	0.015	0.011	0.074	0.050	0.034	0.023
Constant	-0.007	-0.012	-0.002	0.006	0.002	0.012	-0.002	-0.007	-0.053	-0.024	-0.036	0.007	-0.111	-0.062	-0.040	-0.009	0.053	0.038	0.000	0.015
	0.009	0.006	0.004	0.005	0.009	0.009	0.002	0.003	0.016	0.012	0.009	0.007	0.014	0.010	0.007	0.007	0.033	0.022	0.014	0.013
Observations	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830
R-squared	0.04	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.01	0.01

	Incumbent - Within				Incumbent - Across				Entrant				Exiter				Total Change			
	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign
$1\{2005\}_t$	0.078	0.045	0.024	0.008	-0.002	-0.015	0.002	0.011	-0.002	0.008	-0.008	-0.001	0.000	0.018	-0.022	0.003	0.074	0.020	0.040	0.015
	0.019	0.012	0.010	0.010	0.019	0.016	0.006	0.008	0.034	0.021	0.018	0.011	0.030	0.019	0.015	0.012	0.075	0.047	0.033	0.024
$1\{$Quota-Bound$\}_{ch}$ x $1\{2005\}_t$	0.013	-0.002	0.001	0.013	-0.050	-0.024	-0.010	-0.016	0.005	0.003	-0.015	0.017	0.006	-0.009	0.019	-0.003	-0.039	-0.013	-0.042	0.017
	0.031	0.021	0.016	0.012	0.026	0.022	0.009	0.012	0.048	0.033	0.027	0.016	0.046	0.034	0.022	0.016	0.107	0.073	0.048	0.033
Constant	-0.015	-0.013	-0.004	0.002	0.009	0.011	0.000	-0.003	-0.048	-0.021	-0.024	-0.003	-0.105	-0.055	-0.038	-0.012	0.051	0.033	0.010	0.008
	0.007	0.005	0.004	0.003	0.007	0.006	0.002	0.003	0.014	0.008	0.007	0.005	0.012	0.008	0.006	0.004	0.029	0.019	0.013	0.010
Observations	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830	1,830
R-squared	0.53	0.56	0.43	0.49	0.45	0.46	0.50	0.43	0.41	0.44	0.52	0.52	0.46	0.46	0.43	0.46	0.35	0.33	0.37	0.36

	Incumbent - Within				Incumbent - Across				Entrant				Exiter				Total Change			
	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign
$1\{2004\}_t$	-0.013	-0.006	-0.009	0.003	-0.006	-0.006	-0.006	-0.005	0.001	-0.006	0.003	0.011	-0.029	-0.011	-0.016	-0.002	0.011	0.005	-0.004	0.010
	0.013	0.009	0.005	0.007	0.012	0.011	0.003	0.004	0.023	0.015	0.012	0.010	0.021	0.015	0.008	0.008	0.048	0.032	0.019	0.019
$1\{$Quota-Bound$\}_{ch}$	0.020	0.021	-0.005	0.003	-0.013	-0.019	0.001	0.004	0.028	0.014	0.008	0.007	-0.021	-0.032	0.013	-0.002	0.056	0.048	-0.008	0.015
	0.014	0.013	0.004	0.005	0.012	0.010	0.003	0.005	0.024	0.016	0.013	0.011	0.023	0.021	0.008	0.005	0.049	0.034	0.017	0.014
x $1\{2004\}_t$	-0.037	-0.027	0.001	-0.010	0.024	0.017	0.004	0.004	-0.024	-0.008	0.010	-0.025	0.034	0.051	-0.011	-0.007	-0.070	-0.070	0.025	-0.025
	0.022	0.017	0.010	0.009	0.019	0.016	0.005	0.009	0.036	0.025	0.018	0.015	0.035	0.029	0.013	0.011	0.077	0.054	0.029	0.025
Constant	0.005	-0.006	0.008	0.003	0.008	0.005	0.004	-0.002	-0.054	-0.017	-0.033	-0.004	-0.083	-0.051	-0.024	-0.008	0.042	0.033	0.004	0.005
	0.009	0.007	0.003	0.004	0.007	0.006	0.002	0.003	0.014	0.009	0.008	0.006	0.012	0.011	0.005	0.004	0.027	0.019	0.010	0.010
Observations	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786
R-squared	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00

Notes: This table displays the full regressions of equation (3) for Table A.4, which reports the difference-in-differences coefficient on $1\{$Quota-Bound$\}_{ch}$ x $1\{2005\}_t$ for the changes in quality defined in Section 5.3 All regressions are run on the restricted sample of HS codes defined in Section 4.2. The top panel is the baseline specification that corresponds to the left panel of Table A.4. The middle panel includes country-product pair fixed effects in the estimation. The bottom panel is run on the pre-reform years (2002-2004). Standard errors are adjusted for clustering at the eight-digit HS level.

Table A.6: Market Share Decompositions, Processing Exports

	Difference-in-Differences (Quota-Bound vs Quota-Free, 2004-05 vs 2003-04)				Difference-in-Differences, Processing (Quota-Bound vs Quota-Free, 2004-05 vs 2003-04)			
Margin	All	SOE	Domestic	Foreign	All	SOE	Domestic	Foreign
Incumbents	**-0.122**	**-0.106**	-0.013	-0.003	**-0.144**	**-0.106**	-0.019	-0.019
Net Entry								
Adders	**0.116**	-0.011	**0.071**	**0.056**	**0.097**	-0.021	-0.015	**0.133**
New Exporters	**0.037**	-0.003	**0.035**	0.005	0.017	0.001	0.004	0.012
Exiters	-0.031	-0.027	-0.001	-0.003	0.029	-0.044	0.035	0.039
Total Net Entry	**0.122**	-0.041	**0.105**	**0.058**	**0.144**	-0.064	0.024	**0.184**
Total	0.000	**-0.147**	**0.092**	**0.055**	0.000	**-0.170**	0.006	**0.164**

Notes: The left panel replicates the left panel of Table 3, which reports the relative change in 2004 to 2005 vs 2003 to 2004 quantity-based market share between Quota-Bound versus Quota-Free exports, by margin of adjustment and firm ownership type. The right panel reports the analogous regression coefficients from a restricted sample covering processing exports only. In all panels, rows 2 to 4 sum to row 5, rows 1 and 5 sum to row 6, and the first column is sum of the remaining columns. Standard errors are clustered by HS product. Estimated coefficients are bold if they are statistically significant at the 10 percent level or better.

Figure A.1: Textile and Apparel Producers' Value Added per Worker, 2005
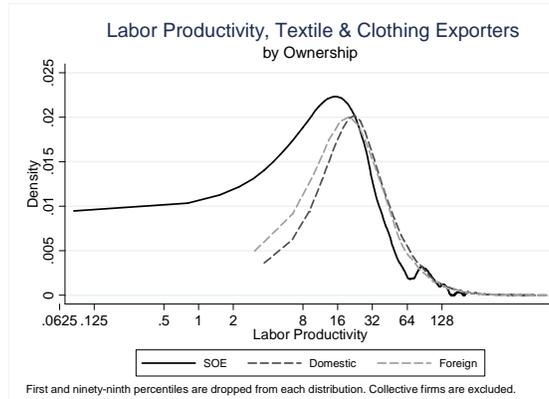
Figure A.2: MFA Incumbents's 2004-5 Change in Market Share vs Initial 2004 Level
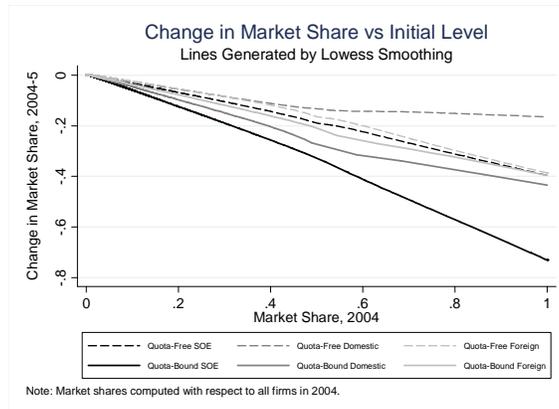
Figure A.3: Average Export Price Growth